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Division of Occupational Hygiene
Recommended safe paractices...

WILLIAM M. SHIPPS
Commissioner

The Commonwealth of Massachusetts
Executive Office of Economic Affairs
Department of Labor and Industries
Division of Occupational Hygiene
39 Boylston Street, Boston 02116

RECOMMENDED SAFE PRACTICE BULLETINS CURRENTLY AVAILABLE FOR DISTRIBUTION

Bull No.	Data Sheet No.	Title
1298		**Accident Prevention**
1169	1	Welding Explosions
		Chemical Data Sheets
1233	1	Formaldehyde
1234	2	Carbon Tetrachloride
1144	3	Benzene
1236	4	Carbon Disulfide
1329	5	Chromates
1300	6	Carbon Monoxide
1328	7	Trichloroethylene
1317	8	Ammonia
1326	9	Mercury
1279	10	Hydrogen Sulfide
1142	11	Fluorides
1149	12	Cadmium
1073	13	Methanol
1278	14	Lead
1180	15	Methyl Ethyl Ketone
1048	17	Acetone
1302	20	Oxides of Nitrogen
1292	21	Petroleum Naphtha
1309	22	Zinc
1323	23	Sulfur Dioxide
1129	24	Cyanides
1251	25	Organic Acetates
1305	26	Toluene
1291	27	Perchloroethylene
1182	28	Beryllium
1074	29	Methyl Chloroform
1255	30	Uranium
1043	31	Butyl Alcohol (N-Butanol)
1250	32	Parathion
1268	33	Isocyanates
1185	34	Epoxy Resins
1280	35	Ozone
1261	36	Chlorine
1262	37	Styrene
1263	38	Aniline
1282	39	Xylene
1285	40	Inorganic Arsenic
1301	41	Tetrachloroethane
1303	42	Dioxane

Bull. No.	Data Sheet No.	Title
		Medical Data Sheets
1192	1	Anthrax
1023	2	Brucellosis
1027	3	Leptospirosis - Weil's Disease
1070	4	Erysipeloid
1156	5	Ornithosis (Psittacosis, Parrot Fever)
982	6	Gas Gangrene
1049	7	Tetanus - "Lockjaw"
1151	8	Poison Ivy Dermatitis
1224	9	Cutting Oil Dermatitis
1244	10	Personel Hygiene in Handling Epoxy Resins
		Mineral Data Sheets
1222	1	Silica
1265	2	Asbestos
1290	3	Mica
1321	4	Pumice
1324	5	Talc
1322	6	Granite
1304	7	Silicon Carbide
1320	8	Aluminum Oxide
1327	9	Fibrous Glass
		Physical Data Sheets
1260	1	X-rays
1294	3	Ultraviolet Radiation
1277	4	Infrared Radiation
1138	5	Noise
1207	6	Excessive Heat
1276	7	Increased Pressure
1075	9	Dampness
1269	12	Cobalt-60
1306	13	Strontium-90
1288	14	Tritium
1264	15	Krypton-85
1273	16	Iridium-192
1281	17	Thorium
1297	18	Radium
1275	19	Leak Testing of Sealed Radioactive Sources
1284	20	Microwaves

(Continued)

Bull No.	Data Sheet No.	Title
		Respiratory Protection Data Sheets
1189	1	Self-Contained Breathing Masks
1223	2	Acid Gas Masks
998	3	Organic Vapor Masks
999	4	Acid Gases and Organic Vapors
942	5	Ammonia Gas Masks
1198	6	Carbon Monoxide Gas Masks
945	7	Universal Gas Masks
958	8	Hose Masks--Type A
959	9	Hose Masks--Type B
969	10	Air-Line Respirators
960	11	Blasting Helmets
936	13	Dispersoid Respirators Toxic Dusts
1157	17	Chemical Cartridge Respirators--Organic Vapors
1176	18	Chemical Cartridge Respirators--Acid Gases
1177	19	Chemical Cartridge Respirators--Acid Gases and Organic Vapors
1173	20	Chemical Cartridge Respirators--Ammonia
997	21	Chemical Cartridge Respirators--Mercury Vapor
1206	22	Massachusetts Sales Representatives of Manufacturers of Respiratory Protective Equipment
947	23	Chemical Cartridge Respirators--Dispersoids and Organic Vapors
1230	24	Dispersoid Respirators--Highly Toxic Dusts
1215	25	Respiratory Protective Devices
1178	26	Chemical Cartridge Respirators--Pesticides
1188	27	Chemical Cartridge Respirators--Paints, Lacquers, Enamels
1211	28	Dispersoid Respirators--Asbestos
1213	29	Dispersoid Respirators--Dusts, Fumes, Mists and Fibers
1214	30	Dispersoid Respirators--Pneumoconiosis and Fibrosis Producing Dusts and Mists
1248	31	Respirators Care and Maintenance Program

Bull. No.	Data Sheet No.	Title
		Ventilation Data Sheets
1122	1	Planers
1094	2	Plating Tanks
1147	3	Spray Booths
1012	4	Portable Grinders
1259	5	Open Tanks
1107	6	Swing Frame Grinders
1209	7	Blasting Rooms
1315	8	Granite Blasting Rooms
1102	9	Tumblers--Hollow Trunnion Type
1053	10	Foundry Shakeout
1174	11	Weather Caps
1041	12	Soldering Bench
1196	13	Disc Grinder--Horizontal Single-Spindle Type
1028	14	Disc Grinder--Vertical Spindle Type
1039	15	Grinding and Polishing Belt
1103	16	Portable Bench Grinder
1104	17	Bucket Elevator
1096	18	Melting Furnace, "Tilting"
1197	19	Pouring Station
1072	20	Make-up Air
1258	21	Laboratory Hood
1318	22	Spray Painting Rooms
		Nursing Data Sheets
1117	1	Plant Shuttle Service
1254	2	Information Concerning Pregnant Employees
1125	3	Eye Safety Program
1127	4	Epilepsy
1293	5	Emergency Medical Transportation
1252	6	Recommended First Aid Supplies
1241	7	First Aid Log
1202	8	Hearing Conservation
1145	9	Heimlich Method of Resuscitation
1154	10	Occupation/Work History
1246	11	Color Coding
1287	12	Massachusetts Poison Control System
1313	13	Services Available for Health and Educational Material
1205	14	Guidelines for Informing Employees of Medical and/or Laboratory Findings
1226	15	First Aid Monthly Summary

No. 1330 Supersedes No. 1298 October, 1981

Right to Know data sheet

2

3

4

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WELDING EXPLOSIONS

GENERAL Many injuries and some deaths have occurred when workers have welded or cut containers which previously have held combustible materials, or which may generate explosive gases or high pressures under electric or gas welding and cutting conditions. This discussion is limited to small containers which have not held nitrocellulose or pyroxylin solutions and which cannot be entered by the worker. It does not apply to large petroleum storage tanks, gas holders or compressed gas cylinders.

HAZARDS An explosion may occur if there is no adequate air vent from the tank or if there is a residue in the container, which has previously held:

a. gasoline, light oil or other volatile liquid which releases flammable vapor at ordinary temperatures.
b. an acid which could react with the metal to form hydrogen.
c. a solid or liquid which releases flammable vapor at elevated temperatures.
d. a finely powdered combustible solid.

PREVENTIVE MEASURES Combustible material should be removed from the interior of the container, necessary precautions being taken to prevent inhalation of toxic gases, vapors or dusts and to prevent ignition through sparks or open flames. Where possible the work should be done outdoors or at least in a well-ventilated room. Cleaning may be accomplished by using water, alkaline powders or steaming. If the substance is readily water soluble, it can be removed by thoroughly flushing the container with water. Otherwise, the container should be cleaned with a hot solution of sodium silicate, tri-sodium phosphate, or soda ash, using a concentration of 2-4 ounces of chemical to a gallon of fresh water or it may be steamed, after a preliminary treatment involving thorough flushing of the surfaces with a hot soda or soda ash solution (one pound of caustic per gallon of water) which fills at least one-quarter of the container.

Cleaning can be supplemented by water filling or inerting. Water is added to within a few inches of the point where welding is to be performed. Inerting is achieved by maintaining an inert atmosphere of 50% carbon dioxide, or 60% nitrogen or neon inside the container while welding is being performed. 80% carbon dioxide and 90% nitrogen or neon are necessary if hydrogen or carbon monoxide could be present.

After cleaning, the container should be inspected to determine if it is free of gas, vapor, liquid or solid. Then testing with an explosion meter or combustible gas indicator should be made for the presence of flammable gases or vapors.

Small containers may explode if not properly ventilated. It is necessary, therefore to have adequate vents to release heated air from inside the container.

Finally, before welding is started, an inspection of the immediate area should be made to insure that it is free of combustible litter, pipe lines and open containers of solids containing flammable materials. (Additional information on welding is found in Bulletin Nos. 921 and 987.)

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No. 1169 Supersedes No. 569 July, 1981

FORMALDEHYDE

HAZARD CLASSIFICATION HIGHLY IRRITANT - Use with caution.

GENERAL Formaldehyde is a colorless, pungent, water-soluble gas. The commercially available aqueous solution, formalin, contains about 37 per cent formaldehyde by weight. Chief uses are in the chemical and textile industries, in synthetic resin manufacturing, in tanneries, and as a preservative and disinfectant. Formaldehyde resins are commonly added to fabric to give it certain desirable characteristics, such as permanent press.

HARMFUL EFFECTS Inhalation. Severe irritation of the mucous membranes, lachrymation, eye irritation, coughing, tightness of chest, laryngitis, bronchitis, or pneumonia may result, although the gas is so irritating that workers usually avoid concentrations high enough to cause these conditions. Individuals can develop some degree of immunity to lachrymation.

Contact with Skin. The solution or gas may cause a severe industrial dermatitis. Exposure may sensitize the skin so that further re-exposure will cause continual dermatitis problems.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure — **1** part of formaldehyde per million parts of air.

PROTECTIVE MEASURES Work areas should be well ventilated. Operations where formaldehyde is used should be enclosed whenever possible and local exhaust ventilation provided. Protective clothing and eye protection equipment should be furnished to and worn by the workers where contact with the liquid occurs. Fabrics containing formaldehyde resins should be prewashed by suppliers to reduce their free formaldehyde content.

MEDICAL CONTROL Irritation or inflammation of the respiratory tract due to the inhalation of formaldehyde requires immediate medical attention. When formalin has been spilled on the skin or splashed into the eyes, the affected part should be flushed immediately with copious amounts of clean, fresh water, and after-effects should be promptly treated by a physician. In cases where dermatitis persists on re-exposure, workers should be transferred to other jobs.

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CARBON TETRACHLORIDE

HAZARD CLASSIFICATION HIGHLY TOXIC--USE WITH RIGOROUS PRECAUTIONS.

GENERAL Carbon tetrachloride is a volatile colorless liquid with a sweetish odor. It is nonflammable. Although used rarely as a fire extinguishing fluid now, it has substantial use as a household solvent, and a cleaner for fur, fabrics and metals. Also, "carbon tet," is used by theatrical make-up artists.

HARMFUL EFFECTS Acute poisoning, from breathing high concentrations of vapor, may result in dizziness and lack of co-ordination during exposure, often followed by nausea and vomiting some hour later. Damage to the liver, kidneys and lungs, not infrequently fatal, may develop. Epileptic seizures are observed in severe exposures. Exposures in combination with other solvents, such as isopropanol, can magnify the toxic effects of carbon tetrachloride.

Chronic poisoning, from more or less continued exposure to lower concentrations, is characterized by loss of appetite, a tendency to nausea and vomiting, with evidence of liver and kidney damage. Occasionally optic nerve neuritis or atrophy has been observed.

Like other solvents, carbon tetrachloride can cause dermatitis if it comes in contact with the skin.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposured--10 parts carbon tetrachloride per million parts of air.

PROTECTIVE MEASURES 1. All receptacles containing carbon tetrachloride must be labeled according to the Massachusetts Labeling Law (Bulletin No. 11, Division of Industrial Safety, Department of Labor and Industries).

2. Large amounts of carbon tetrachloride should not be used except under carefully controlled conditions.

3. Tanks, chambers and other confined spaces should not be cleaned with carbon tetrachloride unless workers are equipped with gas masks or airline respirators approved by the National Institute for Occupational Safety and Health (NIOSH). Ventilation, preferably by means of local exhaust, should be provided whenever more than minimal amounts of carbon tetrachloride are used. Analysis of the air will reveal whether or not the vapor concentration is within safe limits.

4. Whenever carbon tetrachloride has been used to extinguish fires, the area should be evacuated and aired out until the fumes have been cleared away.

MEDICAL CONTROL Heavy drinkers and persons with known diseases of the liver, kidney or lungs should not work with carbon tetrachloride. Exposed workers who complain of dizziness, nausea or vomiting should be immediately removed from contact with carbon tetrachloride. Individuals with a heavy exposure should be hospitalized and observed carefully for possible kidney and liver damage.

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BENZENE

HAZARD CLASSIFICATION *HIGHLY TOXIC AND FLAMMABLE. Use with extreme caution.*

GENERAL Benzene (benzol) is obtained from coal tar or petroleum. It should not be confused with benzine, a term applicable to certain grades of petroleum naphtha which are much less toxic than benzene.

Benzene is a highly volatile, colorless liquid with an agreeable ethereal odor. It is used as a cleaner, solvent and thinner and may be present in paint and varnish removers, rubber cements and lacquers. Many petroleum naphthas contain small amounts of benzene, usually less than 3%, but sometimes higher (up to 10%).

HARMFUL EFFECTS *Acute Poisoning.* High concentrations of benzene when inhaled will cause severe respiratory distress. Following a short period of euphoria, affected individuals may rapidly develop convulsions, lose consciousness and die from respiratory failure unless removed immediately from exposure. Smaller amounts inhaled over a short period may cause headache, dizziness and a "hangover" like sensation.

Chronic Poisoning. Exposure to benzene may cause bone marrow damage and leukemia. Although leukemia is irreversible and uniformly fatal, it is possible to detect other forms of bone marrow damage early and prevent permanent disability. Clinically, damage caused by benzene may appear as anemia (reduced red cells), thrombocytopenia (reduced platelets), or leukopenia (reduced white cells).

MAXIMUM ALLOWABLE CONCENTRATION For occupational exposure (40-hour week)–10 parts of benzene per million parts of air. This corresponds to a urinary phenol level of 75 to 100 mg. per liter in a spot sample taken near the end of the work day.

PROTECTIVE MEASURES All receptacles containing benzene should be labeled in accordance with the Massachusetts Labeling Law (Bulletin No. 11, Division of Industrial Safety, Department of Labor and Industries). Vapors should be removed by exhaust ventilation as near to their source as possible. Air analyses will reveal if concentrations of benzene in the workroom air are harmful. Urine samples obtained from workers near the end of the work period can be used to evaluate their benzene exposure by measuring the total phenol content.

SUBSTITUTES Because it is a carcinogen (causes leukemia), benzene should never be used if it is at all possible to substitute less toxic substances. Toluene or naphtha can often be used instead of benzene. Both are far less toxic.

MEDICAL CONTROL Workers exposed to benzene at any level should have complete blood cell counts performed before employment with benzene and at least annually. A complete blood cell count (CBC) includes evaluation of red cells, white cells, and platelets. Workers with abnormalities of any of these cells should receive more thorough evaluation by a physician and should not be exposed to benzene any further until the CBC is again normal. Any worker exposed to benzene who develops pallor, tendency to bleed, easy fatigability, reduced resistance to infections, dizziness on standing, or aggravation of heart disease symptoms should receive prompt medical attention, as these may be symptoms of blood cell abnormalities.

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CARBON DISULFIDE

HAZARD CLASSIFICATION HIGHLY TOXIC-HIGHLY FLAMMABLE. USE WITH EXTREME CAUTION.

GENERAL Carbon disulfide is a colorless, highly volatile liquid with a characteristic odor. Its low flash point (-22°F.) and ignition temperature (212°F.) make it the most highly flammable of the common solvents. It is used in the viscose process for making rayon, as a disinfectant and fumigant, and as a solvent for fats, oils phosphorus and sulfur. It is also used in analytical laboratories for extraction of air samples from activated charcoal.

HARMFUL EFFECTS Acute exposure to carbon disulfide in high concentrations may cause narcosis with vomiting, diarrhea, unsteady gait, convulsions, and death. Lower concentrations (about 100 ppm.) may cause headache, dizziness, behavioral disturbances, nausea and irritation of the eyes and nose. Direct skin contact may cause absorption and dermatitis.

Chronic exposure to an average concentration of greater than 5 ppm. and continued for a time may cause mental and behavioral disturbances, a wide spectrum of nervous system disorders, interference with sexual function, hypertension, and premature atherosclerotic heart disease and stroke.

MAXIMUM ALLOWABLE CONCENTRATION 10 ppm. as time weighted average. A short term limit of 20 ppm.

PROTECTIVE MEASURES 1. Vapors should be removed by local exhaust ventilation. Analysis of the air will reveal whether or not the vapor concentration is within safe limits. Closed systems should be used wherever practical.

2. Workers should be provided with splashproof goggles and impervious gloves, clothes and footwear. Rubber is unsuitable-synthetic material should be used.

3. It is essential that canister gas masks or air supply respirators approved by the National Institute of Occupational Safety and Health (NIOSH) be immediately available for emergencies.

4. Lights, flames or steam coils must be kept away from areas where carbon disulfide is used or stored.

5. All electrical equipment should be installed and operated in accordance with the recommendations of the National Fire Protection Association, Batterymarch Park, Quincy 02169.

6. All containers should be labeled with warning not to inhale vapors and to keep heat and flames away. See Industrial Bulletin No. 11 of the Department of Labor and Industries.

MEDICAL CONTROL A physician should be summoned at once in case of acute poisoning. The workers should be removed from the toxic atmosphere, and, if unconscious, artificial respiration administered. Workers should be given a thorough medical examination at regular intervals, with particular attention paid to behavioral changes and to effects of carbon disulfide on the cardiovascular and nervous systems.

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CHROMATES

HAZARD CLASSIFICATION *HIGHLY HAZARDOUS - IRRITANT* - Use with caution.

GENERAL Chromium plating is employed extensively in finishing automobile parts, plumbing fixtures, and the like, because of its high luster and resistance to tarnish, and on tools and dies because of its extreme hardness. The bath used for chromium plating consists principally of chromic acid. During the plating process, considerable hydrogen and oxygen are liberated, and these gases may carry a spray of chromic acid into the air. Chromates are extensively used in the tanning industry and as rust inhibitors, as in radiator coolants.

HARMFUL EFFECTS *Inhalation.* Low concentrations produce nasal inflammation and nosebleed. With higher concentrations, perforation of the nasal septum occurs in a high percentage of exposed workers. Studies in the chromate industry by the U. S. Public Health Service indicate that the incidence of lung cancer is higher for chromate workers than for workers in other industries.

Contact with Skin. Dermatitis is common from contact with chromate mist as well as from direct contact. So-called "chrome ulcers" on the hands or other exposed parts of the body result from contact with chromic acid, particularly if the skin is cut or abraded.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure - 0.05 milligram per cubic meter of air (as CrO_3) - 0.05 mg. for zinc chromate.

PROTECTIVE MEASURES As far as possible, protective aprons, shoes and gloves should be worn. Frequent applications of vaseline or mentholatum salve or cotton wicks saturated in mineral oil to the nose and salves to the hands will help reduce the danger of dermatitis or ulceration.

In all cases, chrome plating tanks should be equipped with mechanical exhaust ventilation. For details, see Bulletin No. 1094. If mist cannot be fully removed, dust or mist respirators should be worn.

MEDICAL CONTROL Periodic medical examinations should be made, with prompt treatment upon evidence of chromic acid dermatitis or ulceration of the nasal septum.

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CARBON MONOXIDE

HAZARD CLASSIFICATION HIGHLY TOXIC - HIGHLY FLAMMABLE

GENERAL Carbon monoxide, also called exhaust gas, flue gas, monoxide, coal gas, and white damp, is a colorless, tasteless, odorless, and non-irritating gas. Its presence, therefore, can be detected only by chemical analysis of the air or by means of special detecting devices. It is formed to some extent whenever fuels are burned, especially if there is insufficient air present to permit complete combustion. The exhaust gas from gasoline engines may contain up to 38 percent carbon monoxide. The exhaust odor is not caused by the carbon monoxide, but by other substances present. Propane-powered engines, such as fork-lift trucks, may also produce high concentrations of carbon monoxide.

HARMFUL EFFECTS Carbon monoxide is responsible for a larger number of severe chemical poisonings than any other single agent. The reason for its toxicity is that it deprives the body's cells of oxygen by reacting with hemoglobin in the blood to form carboxyhemoglobin; in this way it interferes with the normal function of hemoglobin, which is to carry oxygen throughout the body.

Acute (short-term) poisoning results from exposure to carbon monoxide at concentrations greater than 200 parts per million parts of air (ppm); death may result if this exposure is prolonged. Exposure to potentially fatal concentrations usually, but not always, produces characteristic symptoms within minutes after exposure begins. These symptoms include a pressure or throbbing sensation in the head, weakness in the wrist, mental confusion, headache, roaring in the ears, nausea, and vomiting. Continued exposure leads to a second stage of acute poisoning, characterized by increasing confusion and paralysis. Headache, dizziness, and inability for clear thinking increase. A person may become indifferent to danger and soothed into drowsiness, a condition resembling alcoholic intoxication. The legs become heavy, consciousness is lost, and vomiting and localized or generalized muscular spasms occur.

The following table correlates the concentration of carbon monoxide in the air with the effects of inhaling that concentration:

Parts CARBON MONOXIDE per Million Parts of Air	Effects
200	Possible headache in 2 to 3 hours
400	Frontal headache and nausea after 1 to 2 hours; headache in the back of the head after 2 1/2 to 3 1/2 hours
800	Headache, dizziness, and nausea in 3/4 hour; collapse and possible unconsciousness in 2 hours

Parts CARBON MONOXIDE per Million Parts of Air	Effects
1600	Headache, dizziness, and nausea in 20 minutes; collapse, unconsciousness, and possible death in 2 hours
3200	Headache and dizziness in 5 to 10 minutes; unconsciousness and possibly death in 30 minutes
6400	Headache and dizziness in 1 to 2 minutes; unconsciousness and danger of death in 10 to 15 minutes
12800	Immediate symptoms; unconsciousness and danger of death in 1 to 3 minutes

Chronic (long-term) exposure to carbon monoxide at any level can aggravate heart disease. Recent evidence suggests an association between heart disease and continued exposure to levels greater than 35 ppm. Whether carbon monoxide exposure causes heart disease is not proved, but it can precipitate heart attacks in workers with heart disease, and it can increase the severity of symptoms in persons with some cardiovascular diseases, such as angina pectoris.

The degree of exposure to carbon monoxide can be determined by analysis of the blood for carboxyhemoglobin. An eight-hour exposure to 35 ppm will result in a total blood level of 5% carboxyhemoglobin. Chronic effects have been observed when this level is exceeded. Workers who smoke tobacco are additionally exposed to carbon monoxide in the tobacco smoke. A one-pack-a-day cigarette smoker has an average carboxyhemoglobin level of 5%, which is increased by exposure to additional carbon monoxide.

Exposure levels high enough to cause unconsciousness in a pregnant woman may result in fetal death or brain damage. Lower exposures may produce nervous system damage or reduced growth in the fetus.

OCCUPATIONAL EXPOSURE LIMITS

OSHA (Occupational Safety and Health Administration):

- The legal permissible exposure limit is 50 ppm averaged over an 8-hour work day.

NIOSH (National Institute of Occupational Safety and Health):

- The recommended exposure limit is 35 ppm averaged over an 8-hour work day, and 200 ppm as the maximum, never to be exceeded.

ACGIH (American Conference of Governmental Industrial Hygienists):

- The recommended exposure limit is 50 ppm averaged over an 8-hour work day, and 400 ppm for at most four 15-minute exposures per day.

PROTECTIVE MEASURES Fuel-burning devices should be kept in good condition and operated properly so that a minimum of carbon monoxide will be generated. Combustion gases from fuel-burning equipment and exhaust gases from gasoline engines should be carried outside by piping or ducts. General ventilation should be supplied to remove any carbon monoxide that escapes into the room air. The ventilation equipment should be explosion-proof. In case of doubt, the atmosphere should be tested to determine the concentration of carbon monoxide present.

The use of propane-powered vehicles instead of gasoline-powered vehicles may reduce the amount of carbon monoxide by approximately one-half. However, the benefit of a propane vehicle is lost if the engine is not properly tuned. It is generally recommended that vehicles be tuned bimonthly or after 100 hours of service, whichever occurs first. Ideally, internal-combustion engines should be replaced with electrically powered vehicles (see Bulletin No. 968 entitled "Control of Carbon Monoxide Gas in Automobile Service Garages").

Where the possibility exists for exposures over 35 ppm, but under 350 ppm, a Type N gas mask approved by NIOSH for carbon monoxide should be used. For higher exposure levels, a NIOSH-approved supplied-air respirator or self-contained breathing apparatus should be used. If respirators are used, a complete respirator protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

EMERGENCY FIRST AID Immediately remove the person from exposure. Keep the patient quiet and warm. Do not use stimulants. Seek medical attention immediately. Begin rescue breathing if breathing has stopped or is labored; begin CPR if heart action has stopped. The critical need is to replace the carbon monoxide in the blood with oxygen as quickly as possible. This process begins immediately on exposure to fresh air, and proceeds six times as fast if pure oxygen can be administered instead of air. Oxygen should be administered only by a qualified person.

MEDICAL SURVEILLANCE Workers who have heart disease or who are pregnant should be kept away from potential carbon monoxide exposure. For those workers who may become exposed it is useful to perform a test for carboxyhemoglobin, which determines the normal level of carbon monoxide in the blood. This test should be promptly repeated if overexposure is suspected.

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No. 1412 Supersedes No. 1300 7/87

TRICHLORETHYLENE

HAZARD CLASSIFICATION *MODERATELY TOXIC – Use with caution.*

GENERAL Trichlorethylene is a heavy, colorless liquid with a characteristic odor which is not unpleasant. It volatilizes to form a colorless, relatively nonflammable vapor. It is used chiefly as a degreasing agent for metals, textiles, leather and wool and as a solvent for oils, greases and waxes.

HARMFUL EFFECTS *Acute poisoning.* Breathing of high concentrations of vapor leads to a state of narcosis with dizziness, nausea, headache, confusion, staggering gait, and less frequently to vomiting and irritation of the mucous membranes. If the exposed person is not removed from the dangerous area, unconsciousness and death may follow. Contact with cold (room temperature) solvent or vapors to the skin may cause a skin irritation resembling first-degree burns.

Chronic poisoning is rare. It occurs only after long continued inhalation of trichlorethylene vapor, causing dizziness, nausea and vomiting. Trichlorethylene, like other fat solvents, leads to cracking of the skin on contact. Isolated cases of jaundice have been reported as a late sequela, and liver damage has been demonstrated experimentally. Workers exposed to trichlorethylene vapors are particularly sensitive to alcohol, and even small amounts may cause unpleasant reactions. Trichlorethylene has been used as a means of "getting high," and repeated inhalation of the fumes may lead to addiction.

MAXIMUM ALLOWABLE CONCENTRATION For occupational exposure– 50 parts of trichlorethylene per million parts of air.

PROTECTIVE MEASURES When trichlorethylene is used as a degreasing agent, proper equipment designed for the purpose should be employed. Home made degreasers are to be avoided. For information on the proper operation, control of fumes, and maintenance of degreasers, refer to Bulletin No. 908, "The Safe Operation of Vapor Degreasers."

The vapors of trichlorethylene are decomposed by short ultraviolet light such as that given off in inert-gas metal-arc welding with the formation of phosgene, a highly toxic gas. Decomposition due to contact with open flames and hot metal surfaces results primarily in the formation of hydrochloric acid. Liquid trichlorethylene is affected by sunlight so is best stored in metal containers.

Workers who enter tanks that contain or have contained trichlorethylene should be provided with and required to wear life lines and supplied air respirators approved by the U. S. Department of Health, Education and Welfare. Oilproof rubber boots, gloves and aprons should be provided, and a co-worker should be stationed nearby outside the tank. An ointment or lotion containing lanolin should be applied to the skin before exposure to the solvent.

The degree of exposure to trichlorethylene may be determined by analysis of air for trichlorethylene and of urine samples for trichloracetic acid. Urine samples should be collected toward the end of the work week. Levels in excess of 150 mg. per liter are indicative of exposures above the maximum allowable concentration of trichlorethylene.

MEDICAL CONTROL If a worker shows any symptoms of poisoning, he should be removed from the hazardous area immediately and a physician called. The administration of oxygen is recommended in prolonged respiratory distress.

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AMMONIA

HAZARD CLASSIFICATION Moderately irritant.

GENERAL Ammonia is a colorless gas with a pungent odor. It is soluble in water, forming an alkaline solution. The gas can be easily compressed into a liquid, and thus it finds use in refrigeration. It is present in many cements and household and commercial cleaners, and is used in chemical industries in the production of other chemicals. Free ammonia, as well as its compounds, is used extensively as a fertilizer. Ammonia is employed for producing a hydrogen atmosphere for annealing processes.

HARMFUL EFFECTS Acute effects. Ammonia in concentrations above the maximum allowable level may cause irritation of the eyes, nose, throat, or bronchial tract. After exposure to high concentrations, the linings of the bronchial tract may be damaged, causing distressing cough, bloody expectoration, and later on bronchopneumonia. Excessive concentrations such as are encountered in accidents may lead rapidly to shock, delirium and even death, due to shock, pulmonary disease or heart failure.

Ammonia may cause severe irritation or even ulceration of the affected parts if the liquid is splashed upon the skin or into the eye, and shock may result if large areas of the body are affected.

Chronic effects. Repeated exposure to slightly elevated concentrations of ammonia vapors may cause irritation to affected mucous membranes.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure, 25 parts of ammonia per million parts of air.

PROTECTIVE MEASURES Closed systems where ammonia is stored or used for refrigeration purposes should be located in well-ventilated rooms. For other processes giving off ammonia, local exhaust ventilation should be provided; but where relatively small amounts of ammonia solutions are handled, good general ventilation may provide adequate control.

In refrigeration or distillation rooms, either supplied air respirators or gas masks approved by the U.S. Department of Health and Human Services National Institute for Occupational Safety and Health, (NIOSH), Testing and Certification Branch (TCB) should always be available for emergency use.

Splash-proof goggles, protective aprons, and gloves should be used by those handling concentrated solutions of ammonia.

MEDICAL CONTROL 1. If splashing occurs, the affected areas should be washed with water for at least 15 minutes, particularly if the eyes are affected. In cases of eye involvement, the worker should be examined by an ophthalmologist.

2. If ammonia has been inhaled, the worker should be immediately removed from the site of exposure **and medically evaluated for acute or subacute pulmonary disease.**

3. Forced oxygen inhalation should be given if breathing has been affected.
4. Counter measures should be instituted if shock is present.
5. Medication for the relief of pain or cough should be prescribed.

PREVENTION

DETECTION EVALUATION

CONTROL

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MERCURY

HAZARD CLASSIFICATION - HIGHLY TOXIC. USE WITH RIGOROUS PRECAUTIONS.

GENERAL Mercury, sometimes called quicksilver, and compounds containing mercury are poisonous. Mercury poisoning may be produced by inhaling dust or vapor containing mercury. At room temperature considerable vapor is given off by metallic mercury. In addition, organic mercury is readily absorbed through the skin.

Metallic mercury is used in thermometers, fluorescent lamps, recording instruments, electric equipment, and also used in amalgams by dentists. Organic mercury compounds are used in insecticides, fungicides and in medicine as diuretics.

HARMFUL EFFECTS Inflammation of the mouth, discoloration of the gums, loosened teeth, slight muscle tremors or loss of appetite may be the first objective indications. Psychic and emotional disturbances, however, may occur as the only signs of excessive exposure. Common symptoms are excitability, frequent anger, inability to concentrate, fearfulness, depression, indecision, loss of memory, drowsiness, or insomnia. This change in behavior may be best described by a spouse or fellow-worker rather than the affected worker. The fine tremor may affect the hands, head, lips, tongue or jaw and may produce a change in handwriting, making it either illegible or inconsistent with letters omitted.

Acute mercury poisoning is accompanied by metallic taste, marked salivation, swelling of gums, vomiting, and bloody diarrhea. Kidney failure may also be seen.

Chronic mercury poisoning may show the same symptoms as seen in acute mercurialism, although less pronounced and not always recognized as such. Prolonged exposure to mercury over long periods of time will lead to a disease of the nervous system characterized by marked tremor, unsteady gait and characteristic changes in personality, i.e., "Mad as a hatter."

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure - 0.05 mg. of mercury per cubic meter of air*

PROTECTIVE MEASURES 1. The mercury content of the atmosphere at the place of employment should not exceed the maximum allowable concentration. Where air tests indicate excessive exposure, improved conditions should be obtained by appropriate ventilation, changes in manufacturing procedures, and, most important, insistence on good housekeeping. Mercury spills should be cleaned up at once.

2. The amount of mercury used should be recorded. This will give an indication of any loss due to spillage.

3. Floors, tables and chairs in the workroom should be impervious to mercury, smooth and free from cracks and recesses. Where it is difficult to prevent spillage, floors and benches should be sloped so that the mercury will drain into receptacles containing water. Barriers to prevent the spread of mercury outside the immediate work area should be provided. Pans are commonly placed under some operations, e.g., during filling, to contain minor spills.

4. If the floor and benches have been contaminated with mercury, treatment with calcium polysulfide or ferric chloride solution will greatly reduce the amount of mercury vapors given off. Dry sweeping prior to treatment with the above compounds or water should be avoided.

5. Personal hygiene to remove residual mercury from the skin is important; also, good mouth hygiene and dental care should be practiced.

6. Resource information is available on Bulletin No. 1270.

*This applies to most mercury compounds. Lower limits should be used for alkyl mercury compounds which are unusually toxic.

MEDICAL CONTROL Persons who handle mercury should be given physical examinations at regular intervals, with special attention to the early signs of mercurialism, such as tremor, irritability and stomatitis, which simply means inflammation of the mucous tissue of the mouth. Mercury urinalysis should be performed at regular intervals. A value of more than 0.15 milligram of mercury per liter of urine is considered indicative of excessive exposure.*

In the event of acute poisoning, evaluation and treatment of workers should be initiated by an occupational health physician as early as possible.

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MASS. MA13.2: R245

HYDROGEN SULFIDE

HAZARD CLASSIFICATION HIGHLY TOXIC AND HIGHLY FLAMMABLE - Use with Extreme Caution

GENERAL Hydrogen sulfide (CAS# 7783-064) is a colorless gas at room temperature. It is also known as hydrosulfuric acid; sulfur hydride; sulfurated hydrogen, hepatic gas and stink damp. Exposure to hydrogen sulfide may occur in the following industries: sewage treatment plants, fishing and fish processing, tunnel evacuation, petroleum refineries, oil and gas drilling, rayon manufacturing, glue and gelation manufacturing, slaughterhouses and rendering plants, tanneries and dye manufacturing.

PHYSICAL PROPERTIES Hydrogen sulfide is a toxic, highly flammable gas at room temperature. Its lower and upper explosive limits in air are 4.3% and 46% by volume, respectively. It is soluble in weak acids and carbon disulfide. Hydrogen sulfide is heavier than air. In areas with little air movement, it will settle to the floor or ground.

ODOR THRESHOLD Hydrogen sulfide can be detected by odor at concentrations below 1 part hydrogen sulfide per million parts air (ppm). Its odor is that of rotten eggs. At approximately 30 ppm, hydrogen sulfide has a sweet to sickeningly sweet odor. At this and higher concentrations, you may rapidly lose your ability to smell the gas. At concentrations immediately dangerous to life and health (300 ppm), hydrogen sulfide may be completely odorless.

HARMFUL EFFECTS <u>Acute (short-term) exposure</u> to very high concentrations of hydrogen sulfide gas (300 ppm or more) can cause immediate incapacitation and death. Acute exposure to lower concentrations may produce eye, nose and throat irritation (with eye irritation usually being the first symptom observed); headache; dizziness; nausea and vomiting; staggering gait; convulsions and coma.

<u>Chronic (long-term) exposure</u> to low concentrations of hydrogen sulfide may cause hypotension, nausea, anorexia, weight loss, incoordination and chronic cough.

MAXIMUM ALLOWABLE CONCENTRATION Exposure to hydrogen sulfide should not exceed 10 ppm for any 10 minute period during the work shift.

PROTECTIVE MEASURES Engineering controls should be used to reduce employee exposure to hydrogen sulfide to below the maximum allowable concentration. These controls may include enclosure of the work process and/or mechanical ventilation. Continuous monitoring using a direct reading hydrogen sulfide monitor equipped with a spark-proof alarm should be performed in work areas where exposures could exceed the maximum allowable concentration. The monitor should be provided with a two-tier alarm system to alert employees when exposures exceed 10 and 50 ppm. At 50 ppm, workers should be evacuated from the workplace. Those performing emergency repair or cleanup work should wear appropriate respiratory protection.

Respirators should be used only until such time as engineering controls can reduce exposures to safe levels, for nonroutine maintenance and for emergencies. A complete respiratory protection program, as outlined in the OSHA standard (29 CFR 1910.134), should govern respirator use. The minimum respirator protection for hydrogen sulfide overexposure requires the use of full facepiece supplied air or self-contained breathing apparatus (SCBA) respirators. Only NIOSH or Mine Safety and Health Administration (MSHA) approved respirators should be used.

Work in confined spaces may be particularly hazardous. Written authorization should be required to enter a confined space. Initial and continuous monitoring of the air in confined spaces for hydrogen sulfide, oxygen content and combustible gases should be performed. The confined space should be continuously ventilated using mechanical ventilation. Work in a confined space should require the use of approved respirators. A buddy system should always be used when performing confined spaces work.

TRAINING Employers are required [under the Occupational Safety and Health Administration's (OSHA) Hazard Communication Standard and the Massachusetts Right to Know Law] to provide hazard information and training to all employees potentially exposed to hydrogen sulfide. The training should include information on health hazards and on safe handling practices.

SPILL PROCEDURES Liquid spills need immediate attention as liquid hydrogen sulfide quickly evaporates. Immediately evacuate all unnecessary personnel. Personnel performing cleanup should wear a full facepiece self-contained breathing apparatus (SCBA) in pressure-demand or other positive pressure mode. Cleanup workers should also wear rubber protective clothing and boots. Ignition sources should be removed from the area. Liquid spills can be absorbed with cement powder or fly ash. Vapor concentration can be reduced by applying water spray to the contaminated atmosphere. The use of crushed limestone or sodium bicarbonate will neutralize the spilled hydrogen sulfide and/or hydrogen sulfide-water mixture.

EMERGENCY FIRST AID

Inhalation: Persons inhaling very high concentrations of hydrogen sulfide should be immediately removed from the exposure area. If the victim is no longer breathing, perform artificial respiration. A qualified person should administer oxygen, if available. Maintain the air passage (important for persons vomiting). Keep the affected person warm and at rest. Get medical attention immediately.

Skin Contact: Contaminated skin should be washed immediately with water for 15-20 minutes and contaminated clothing should be removed. Medical attention is necessary for skin burns from hydrogen sulfide. The contaminated clothing should be washed down thoroughly before reuse and only impermeable clothing should be used.

Eye Exposure: For workers suffering severe eye irritation, remove immediately from the exposure area. Flush the eyes with large amounts of water, occasionally lifting the upper and lower eyelids. Get medical attention immediately.

ANTIDOTE Amyl nitrate or sodium nitrite can be used to aid in the formation of sulfmethemoglobin, thus removing sulfide from combination with tissues. Administration of antidotes should be performed by qualified medical personnel. The nitrate antidote is itself toxic.

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FLUORIDES

HAZARD CLASSIFICATION HIGHLY TOXIC AND IRRITATING - Use with rigorous precautions.

GENERAL Hydrofluoric acid and its soluble salts, such as sodium and ammonium fluoride, are the most reactive compounds of fluoride commonly found in industry. Insoluble fluorides, such as cryolite and fluorspar, which are minerals, are also frequently used. Other fluorine compounds include silicon tetrafluoride (a gas), fluorosilicates and fluoroborates. Organic fluorides, such as the Freons, are considered less toxic, as a rule, than the inorganic fluorides.

Inorganic compounds of fluorine are used as fluxes in magnesium casting, brazing and in welding of stainless steel and aluminum. Hydrofluoric acid is employed as an etching agent for glass. Sodium fluoride is sometimes added to water supplies as a dental hygiene measure and is also employed as an insecticide. A fluorine compound, sodium fluoroacetate, is a highly effective rat poison.

HARMFUL EFFECTS Hydrofluoric acid is a strong irritant, attacking the skin and producing lesions which are slow-healing. The soluble fluorides, when inhaled as dust or fume, irritate the nose and throat, sometimes causing ulceration of the mucous membranes. The insoluble fluorides are not irritants. Prolonged inhalation of fluoride dusts or ingestion of soluble fluorides may result in fluorosis, which involves mottling of the teeth and bone changes. Weight loss and stomach and nervous disorders may also occur.

Fluorocarbons (Freons), such as those used in degreasers, as refrigerants, and as aerosol propellants have been associated with toxic effects on the heart. Potentially fatal cardiac arrhythmias may result from over-exposure to these Fluorocarbons.

Numerous fatal poisonings from the accidental ingestion of sodium fluoride are known to have occurred.

MAXIMUM ALLOWABLE CONCENTRATION As fluoride dusts and smokes, 2.5 milligrams per cubic meter of air. For hydrogen fluoride, 3 parts per million parts of air.

PROTECTIVE MEASURES Rubber gloves, aprons, and goggles should be worn during work with hydrofluoric acid; and the operation should be adequately exhausted. Welding operations in which fluoride fluxes are employed should have local exhaust ventilation.

MEDICAL CONTROL Pre-employment examinations should be given to all prospective employees and should include a dental check for condition of the enamel. Regular dental checks, careful recording of body weight and urinalyses for fluorides are suggested to complete the medical control program. Five milligrams of fluorine per liter of urine is a significant concentration, and job rotation should be considered if this value is exceeded.

In case of accidental burns from hydrofluoric acid, immediate flushing of the affected area with water and rinsing for at least one hour are most important, particularly if the eyes are affected.

Medical personnel should be alert to the possibility that cardiac arrhythmias (skipped beats, palpitations) may be caused by Fluorocarbon (Freon) exposure.

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No. 1354 Supersedes No. 1142 December, 1983

CADMIUM

HAZARD CLASSIFICATION HIGHLY TOXIC - Use rigorous precautions, especially when fumes are present.

GENERAL Cadmium metal is often a major component of alloys used for bearings, silver solders and fusible metals. Compounds of cadmium are used to some extent in paints and insecticides. The oxide of cadmium is used in the cadmium-nickel storage battery. Cadmium is sometimes applied by the metal spraying process and frequently by electroplating.

When cadmium alloys or solders are melted, and especially when cadmium coated metal is welded or cut with a torch, dangerous amounts of cadmium fumes may be given off.

HARMFUL EFFECTS Acute: Inhalation of high concentrations of cadmium fumes produces a variety of symptoms. Initially symptoms may be no more than mild upper respiratory tract irritation. During the next few hours the symptoms increase in severity and may be accompanied by pain in the chest, cough, sweating and chills. Eight to 24 hours after exposure symptoms may intensify with shortness of breath and generalized weakness associated with pneumonia and pulmonary edema. Of those following this pattern about 15% die within four to seven days.

Chronic: Long-continued exposure to smaller amounts of cadmium dust is said to produce chronic cadmium poisoning, characterized by pulmonary emphysema and renal disease, with excretion of a protein in the urine. An association of cadmium exposure with high blood pressure has been reported. A yellow ring at the lower half of the teeth is frequently present. When cadmium is ingested it causes a severe gastroenteritis.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure - 0.05 mg. of cadmium per cubic meter of air.

PROTECTIVE MEASURES Adequate ventilation should be maintained wherever cadmium compounds are handled or workers are exposed to cadmium fumes arising from melted alloys containing cadmium.

Brazing with silver solder containing cadmium should be performed within a booth, if possible, ventilated at 150 cfm. per square foot of opening. If a booth cannot be used, a local exhaust ventilating system usually provided with a 4 inch diameter flexible duct and a flanged hood placed to within 6 inches from the point of operation and ventilated to provide a control velocity of not less than 250 feet per minute should be used.

For short exposure, a respirator of a type approved by NIOSH for protection against metal fumes may be used.

MEDICAL CONTROL There should be supervision of workers exposed to cadmium so that at the earliest appearance of suspicious symptoms they may receive immediate medical evaluation. Acute inhalation may lead to pneumonia and pulmonary edema and is therefore treated with oxygen and prophylactic penicillin. Gastritis is treated with milk ingestion, magnesium sulfate by mouth, and replacement of lost fluid. Those chronically exposed should be evaluated at intervals of one to three years with lung function and kidney function tests in order to detect early evidence of cadmium associated disease.

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METHANOL

HAZARD CLASSIFICATION TOXIC - FLAMMABLE - Use with caution.

GENERAL Methanol (methyl alcohol or wood alcohol) is a colorless, highly volatile liquid. It is used as a solvent for lacquers and plastics, in paper coating, as a denaturing agent for varnish, and as an anti-freeze. It is widely used in chemical synthesis, as a solvent for inks, dyes, resins, adhesives, and rubber for coating fabrics. It is added to ethyl alcohol to act as a denaturant.

HARMFUL EFFECTS Acute poisoning is usually the result of ingestion by persons mistaking methanol for ethanol. However, there have been cases of blindness caused by skin absorption and inhalation. The symptoms of acute poisoning appear within one hour and include dizziness, cyanosis, nausea, vomiting and impairment of vision which may lead to blindness, severe restlessness, unconsciousness and, in severe cases, death.

Chronic poisoning results from continued exposure to concentrations very much in excess of recommended limits. Symptoms vary depending on the severity of exposure and individual sensitivity. They include irritation of the mucous membranes (eyes, nose and mouth), headache, ringing in the ears, vertigo, insomnia, nystagmus, dilated pupils, clouded vision, nausea, vomiting, colic and constipation. Exposure to liquid methanol can cause dermatitis of the skin and forearms and other exposed areas.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure - 200 parts of methanol per million parts of air.

PROTECTIVE MEASURES Working areas where methanol is handled should be well ventilated. Equipment and processes which use methanol should be provided with local exhaust ventilation. Impermeable gloves and other protective clothing should be provided to persons who must handle methanol directly.

Tanks and other confined spaces which have contained methanol should be thoroughly ventilated before workers are permitted to enter. If this is not possible, workers entering such enclosures should be provided with airline respirators and rescue harnesses, and a helper should be stationed outside the enclosure.

MEDICAL CONTROL There should be supervision of workers exposed to methanol so that at the earliest appearance of the above symptoms they can receive immediate attention.

Once methanol poisoning has occurred, intensive treatment is needed. Vomiting should be induced in those who are still conscious, and large quantities of fluid should be given prior to the arrival of a physician.

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MASS. MA13.2: R245/no.14

LEAD

HAZARD CLASSIFICATION HIGHLY TOXIC. USE RIGOROUS PRECAUTION WHEN DUST OR FUMES ARE PRESENT.

GENERAL Lead is one of the most extensively used of the heavy metals. Metallic lead is a major component of solder, type metal, battery plates, plumbing fixtures, and linings for chemical tanks. It is a common constituent of bronzes and is occasionally added to certain steels. Compounds of lead are widely used in the manufacture of storage batteries, ceramics, glass, anti-knock agents in gasoline, plastics and paint.

HARMFUL EFFECTS Occupational lead poisoning occurs chiefly from inhalation of the dust or fume of lead or its compounds. Gastro-intestinal absorption after swallowing white lead (lead carbonate) is the cause of most lead poisoning in children and may also affect workers handling the compound. Lead tetraethyl is the only compound which is absorbed rapidly through the skin. Touching cigarettes with lead-soiled hands may lead to breathing lead fume.

The most frequent early symptoms of lead poisoning are anxiety, nervousness, irritability, and abnormal tiredness. A variety of aches, pains, and muscle weaknesses are common. Muscle paralysis such as "wrist drop," severe abdominal cramps or "lead colic," and discoloration of the teeth or "lead line" are characteristic of only the most severe cases. Anemia is frequently found if a blood test is performed. Any or all of these effects may occur after a few weeks of relatively heavy lead absorption, and they may last for many months after the exposure ceases.

Possible late effects of lead exposure include kidney disease and high blood pressure. It is not known how much exposure is needed to produce these severe delayed effects. Heavy alcohol intake in workers who handle lead will hasten the development of acute symptoms of lead poisoning.

ENVIRONMENTAL CONCENTRATIONS Maximum allowable concentrations for lead compounds in air are shown in the following table.

Substance	Maximum Allowable Concentration (Milligram per Cubic Meter)
Inorganic lead dust and fume	0.05
Organic lead compounds, such as tetraethyl lead	0.05

Actions to be taken at different environmental concentrations of inorganic lead dust and fume are as follows:

Lead Concentration (Milligram per Cubic Meter)	Action
0.00 - 0.03	None
0.03 - 0.05	Consider changes in environmental controls - institute biological monitoring program
Greater than 0.05	Institute environmental controls and changes in work practices. Provide appropriate NIOSH-approved respirators. Continue biological monitoring.

PROTECTIVE MEASURES Processes which tend to produce harmful concentrations of lead dust or fume in the air include shoveling, weighing, mixing and other handling of lead compounds in powder form; sanding and grinding of lead, lead alloys or lead-painted surfaces; melting and pouring of lead-bearing bronze or steel; welding or oxy-gas cutting of lead-painted metal; lead smelting; lead burning, scraping or abrasive blasting; lead or lead paint spraying; drossing of lead kettles; and annealing. If possible, all these processes should be enclosed or partially enclosed and exhaust ventilated. The exhausted air should not be recirculated back into the workroom under any circumstances. Adequate precautions should be implemented to insure that the outside environment is protected. If control of the dust or fume in certain cases is impractical by using an enclosure or local exhaust, the exposed workers should be protected by NIOSH-approved airline hoods or respirators or by approved lead dust or fume respirators. Good plant housekeeping is essential where lead dust is present. The machines, benches and floors should be cleaned on a regular basis and preferably by the use an industrial vacuum cleaner or else by wet sweeping. Good personal hygiene should be practiced by workers handling lead. Eating, drinking and smoking should be prohibited in work areas. Hand washing facilities must be available to prevent hand contamination of food and cigarettes.

MEDICAL CONTROL Pre-employment examinations are recommended for employees who will be exposed to lead. Most important are pre-employment blood lead and zinc protoporphyrin determinations and history of past lead employment. Workers must be informed in advance of the dangers of lead exposure and warned about the symptoms noted above. Any worker who develops any of the above symptoms while working with lead should be examined by a physician and have blood lead and zinc protoporphyrin levels measured. Workers with elevated lead levels and clinical symptoms must be removed from the exposure. Treatment with chelating agents, such as EDTA and penicillamine, is rarely necessary and is never a substitute for complete removal from lead exposure.

The following interpretations of blood lead measurements are made:

Blood-Lead Concentration (Micrograms µg%)	Action
Up to 40	Repeat in six months if lead exposure continues
Above 40	Repeat in 8 weeks
Above 60 or if the average of the last three samples is greater than 50 unless the last sample is less than 40	Remove worker from job

The OSHA Lead Standard states medical removal is required for a blood lead level of greater than (or equal to) 60 µg% which has been confirmed within two weeks or if the average of the last three blood samples or all blood samples over the previous six months (whichever is over a longer time period) is 50 µg% or greater unless last blood sample is 40 µg% or less. Blood lead levels are done monthly during the removal period.

Urine-lead determinations are alternate means for assessing lead exposure but are less meaningful than blood-lead measurements. Urine lead tests, furthermore, cannot be used to meet OSHA medical requirements. Nevertheless, the following interpretations are utilized:

Urine-lead Concentration (Milligram per Liter)	Action
0.00 - 0.08	Repeat in six months (if lead exposure continues)
Above 0.08	Repeat in two weeks. If urine-lead remains above 0.08, perform blood-lead analysis.

The urine values reported are adjusted to a specific gravity of 1.024. The results of abnormally dilute samples are less reliable than those of normal concentration. Values out of line with those of other workers with similar jobs should be checked again.

ZINC PROTOPORPHYRIN Zinc protoporphyrin (ZPP) or free erythrocyte protoporphyrin (FPP) are products of the body's heme synthesis. Lead exposure affects this system and causes an accumulation of this metabolic product in the blood and is indicative of body dysfunction. A correlation between elevated ZPP or FPP and blood lead has been studied, but the relationship is not too well defined. It is well established, however, that a high blood lead is usually accompanied by a corresponding elevation in ZPP or FPP. Elevated ZPP or FPP may persist for several weeks after lead exposures have ceased and blood-lead levels are reduced. No medical removal level for ZPP or FPP has been determined at this time.

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No. 1361 Supersedes No. 1332 October, 1984

METHYL ETHYL KETONE

HAZARD CLASSIFICATION MODERATELY TOXIC, IRRITANT AND FLAMMABLE

GENERAL Methyl ethyl ketone, also known as 2-butanone, is used as a solvent in the artificial leather and lacquer industries as well as in the manufacture of smokeless powder and colorless synthetic resins. It has a very distinct odor which resembles that of acetone.

HARMFUL EFFECTS **Acute Effects.** Methyl ethyl ketone (MEK) is irritating to the eyes and nose and when inhaled has intoxicant effects similar to those of ingested ethanol. Average work exposures as low as 50 ppm. have been shown to cause persistent rhinorrhea and unusual fatigue. Accidents both at work and after work may be precipitated by the intoxicant effects of methyl ethyl ketone. High concentrations produce narcosis and gasping respiration and may damage the liver and other vital organs.

Chronic Effects. Chronic neurologic disease such as that caused by methyl butyl ketone (M.B.K.) has not been reported in association with methyl ethyl ketone exposure.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure - 200 parts of methyl ethyl ketone per million parts of air.

PROTECTIVE MEASURES The operation should be enclosed wherever possible and local exhaust ventilation provided to assure that the working area will be well ventilated. Air analyses should be performed to determine the concentrations in the working atmosphere.

MEDICAL CONTROL Workers briefly exposed to high concentrations will generally seek a source of fresh air for relief, and this is the appropriate treatment. As workers exposed to methyl ethyl ketone may have difficulty with co-ordination, they should not perform jobs involving a potential danger to themselves or to others. The worker should be removed from the methyl ethyl ketone exposure as soon as the symptoms are experienced, and a physician should be called to treat the worker.

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No. 1180 Supersedes No. 1099 March, 1980

ACETONE

HAZARD CLASSIFICATION SLIGHTLY TOXIC - HIGHLY FLAMMABLE

GENERAL Acetone is a colorless liquid with a rather pleasant odor. It is used extensively as a solvent in various industries. It readily ignites at room temperature and even at 4 F. Air containing from 2% to 13% acetone vapor forms an explosive mixture.

HARMFUL EFFECTS Acute Poisoning. Inhalation of high concentrations of acetone vapors produces dryness of the mouth and throat, slight dizziness, nausea, incoordinated movements, loss of co-ordinated speech and later drowsiness and, in extreme cases, coma.

Chronic Poisoning. Inhalation of small quantities of acetone vapors over long periods causes irritation of the respiratory tract, coughing, and headache.

Dermatitis. Continued contact of acetone with the skin dissolves the fat of the skin and causes dryness and irritation.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure - 500 parts of acetone per million parts of air.

PROTECTIVE MEASURES If considerable amounts of acetone are used, workrooms should be thoroughly ventilated and, if possible, the vapors should be removed at the source of origin.

Workers exposed to high concentrations should wear non-ventilated goggles to protect the eyes.

Analysis of expired breath for acetone and urine for ketones may be performed to determine acetone exposure.

Skin contact should be avoided. If this is not possible, then skin should be protected by gloves or barrier creams.

MEDICAL CONTROL In the event of severe poisoning, remove the individual immediately from exposure and change out of the contaminated clothes and shoes. Medical attention should be directed at counteracting coma and acidosis. Skin irritations must be treated with fat-restoring ointments

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OXIDES OF NITROGEN

HAZARD CLASSIFICATION HIGHLY TOXIC

GENERAL The air we breathe contains about 20 per cent oxygen, and the balance is almost all nitrogen. When these two gases, oxygen and nitrogren, combine chemically, they form oxides of nitrogen, ordinarily a mixture of nitric oxide and nitrogen dioxide, sometimes called nitrous fumes. This chemical combination takes place only under special circumstances, as in the presence of the electric arc or oxyacetylene torch. Hence in welding operations by either of these methods and particularly in inert gas shielded welding we find nitrogen oxides present in the atmosphere. These gases are also present in the exhaust from Diesel and gasoline engines.

Many substances used in industry contain nitrogen in a form which may readily produce oxides of nitrogen. These gases are given off by exploding dynamite, by burning celluloid, or by nitric acid coming in contact with metals or organic materials. Fresh silage undergoing fermentation sometimes forms nitrogen dioxide.

HARMFUL EFFECTS (1) Acute--Nitrogen dioxide is a pulmonary irritant. Early symptoms of the effects from exposure to harmful concentrations may include headache, nausea, coughing or irritation of the throat. Pulmonary edema, the most serious consequence of nitrogen dioxide inhalation, usually does not develeop for at least several hours following exposure.

(2) Chronic--The effects of continued exposure to low concentrations of nitrogen dioxide are not well defined. Headache, dizziness, and chronic irritation of the respiratory passages have been reported.

The effects of nitric oxide are usually minor in comparison with those caused by the dioxide.

MAXIMUM ALLOWABLE CONCENTRATION Nitrogen dioxide--3 parts per million parts of air. Nitric oxide--25 parts per million parts of air.

If the source of these gases is the exhaust from Diesel engines, the nitrogen dioxide concentration in the air should be kept below 2 parts per million.

PROTECTIVE MEASURES All important sources of nitrogen dioxide gas, such as "bright dip" tanks, should be enclosed or equipped with local exhaust ventilation. Good general ventilation should be provided wherever oxyacetylene flames or high-intensity electric arcs are used in the open workroom. When blasting is done in confined spaces, the area should be ventilated before an individual enters.

MEDICAL CONTROL Any worker having the signs and symptons of acute poisoning from nitrous fumes should be removed from the offending atmosphere and kept at complete bed rest. The patient should be hospitalized as soon as possible and watched closely for the development of pulmonary edema. Supportive therapy should be given at the earliest sign of pulmonary edema and specific antibiotic therapy should be given for secondary bacterial infection.

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PETROLEUM NAPHTHA

HAZARD CLASSIFICATION *SLIGHTLY TOXIC; HIGHLY TO MODERATELY FLAMMABLE, DEPENDING ON BOILING RANGE.*

GENERAL Naphtha is a general term applied to various mixtures of petroleum hydrocarbons, usually limited to those with boiling ranges between 100 and 450 degrees F. Typical naphthas and boiling ranges include Petroleum Ether, 104-140 degrees F. Rubber Solvent Naphtha, 100-300 degrees F. Stoddard Solvent or Mineral Spirits, 300-400 degrees F. Gasoline is a mixture of petroleum hydrocarbons, boiling over a similar range (100 to 400 degrees F) but is usually less highly refined than naphthas used as solvents. Naturally-occurring aromatic hydrocarbons, such as benzene, toluene and xylene, may be found in the lower boiling naphthas.

Naphthas are among the most widely used solvents, being employed in dry cleaning, degreasing, and extraction processes, and as solvents or diluents for rubber, paint, varnish and lacquer. Their advantages are low cost and low toxicity; their disadvantages, flammability and relatively poor solvent power.

HARMFUL EFFECTS (1) *Acute poisoning* may result in dizziness, blurred or doubled vision and unsteady gait. Nausea or vomiting and headaches sometimes occur. A massive exposure may result in sudden collapse, coma and possibly death.

(2) *Chronic poisoning* does not always reveal characteristic symptoms. The more common ones reported are generalized weakness, tremors, coldness and numbness of the extremities and increased nervousness in the individual. Some investigators have found anemia as a presenting sign.

(3) *Local effect on the skin* Excessive contact may lead to loss of oil from the skin, causing it to become dry and cracked. The presence of aromatic hydrocarbons, particularly benzene, in the lower boiling naphthas, may increase the hazard of both acute and chronic poisoning.

MAXIMUM ALLOWABLE CONCENTRATION 400 parts per million parts of air for the more volatile naphthas, such as those used as rubber solvents. The less volatile mixtures are somewhat more toxic.

PROTECTIVE MEASURES Processes which produce large amounts of naphtha vapor, such as varnish spray or dip operations, or rubber spreaders, should be equipped with local exhaust ventilation. Rooms with numerous small sources of naphtha vapor should have good general ventilation. Fire department regulations regarding the handling of flammable solvents should be followed.

MEDICAL CONTROL Any worker suffering from acute poisoning should be removed from the offending atmosphere and observed until all signs and symptoms have disappeared. In the case of unconsciousness, artificial respiration should be given while awaiting the arrival of a physician.

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ZINC

HAZARD CLASSIFICATION SLIGHTLY TOXIC

GENERAL Small amounts of zinc are normally present in our foods. The average daily intake is said to be about 10 milligrams.

Industrially zinc metal is used both alone and in combination with other metals, as in brass and bronze. Galvanized iron is sheet iron to which a coating of zinc has been applied.

Zinc oxide, the most important compound of zinc, is used as a pigment in paints, rubber, and the like. Zinc stearate is widely used as a nonirritating baby powder.

HARMFUL EFFECTS Inhalation of high concentrations of zinc oxide fumes arising from molten zinc, brass or bronze may produce a metal fume fever known as "zinc chills," "galvo," or "spelter shakes." There is no definite evidence of chronic illness resulting from repeated exposure. The hazard may be present in foundry operations, in galvanized iron welding, and in zinc metal spraying. Usually there is no hazard in galvanizing, in the manufacture of zinc castings, or in handling zinc oxide.

Fumes from soldering fluxes containing zinc chloride may cause irritation of the mucous membranes. Zinc chloride fumes in high concentrations have been associated with lung damage and in one case with an acute fibrosing intrastitial lung disease.

Zinc chloride in flux or impregnated in timber is associated with ulceration of fingers, hands and forearms. Zinc chromate in primer paints has been reported to cause nasal ulceration and dermatitis. (MAC: 0.05 mg/m^3)

MAXIMUM ALLOWABLE CONCENTRATION 5 milligrams of zinc oxide fume per cubic meter of air.
1 milligram of zinc chloride fume per cubic meter of air.

PROTECTIVE MEASURES There should be local exhaust or general ventilation capable of maintaining the atmospheric concentrations of zinc oxide fumes below the maximum value given above. A worker who is unavoidably exposed to high concentrations of zinc oxide fumes should be provided with a respirator of a type approved by the U. S. Department of Health and Human Services, National Institute for Occupational Safety and Health, (NIOSH), Testing and Certification Branch (TCB).

MEDICAL CONTROL Any worker developing "zinc chills" should be seen by a physician. Although there is no specific treatment for this condition and recovery is usually complete in less than 24 hours, it is of importance that other more serious illnesses with the same symptoms be ruled out.

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SULFUR DIOXIDE

HAZARD CLASSIFICATION Highly irritant - moderately toxic.

GENERAL Sulfur dioxide (SO_2) is a colorless gas with a characteristic highly pungent odor. It is formed when sulfur is burned and when sulfite solutions are mixed with acid. The atmosphere in areas where large amounts of coal or oil are burned, especially in the vicinity of smelters, contains measurable amounts of sulfur dioxide.

Sulfites are used as bleaching agents in the tanning and textile industries, in photography, and as preservatives. Sulfur dioxide is employed as a refrigerant and fumigant and in chemical manufacture.

HARMFUL EFFECTS (1) Acute effects. When the extent of exposure is 1-5 parts per million or greater, there may be irritation of the throat, nose, and eyes. Some may experience increased resistance to breathing. If the extent of exposure is great, severe inflammation of the eyes and bronchi, bronchial pneumonia, bronchial asthma, and possibly edema of the larynx and lungs may develop.

(2) Chronic effects. Many workers may experience progressive loss of lung function on chronic exposure to sulfur dioxide in air of concentrations greater than two parts per million.

MAXIMUM ALLOWABLE CONCENTRATION Two parts of sulfur dioxide per million parts of air.

PROTECTIVE MEASURES Gas masks approved by the U.S. Department of Health, and Human Services, National Institute for Occupational Safety and Health, (NIOSH), Testing and Certification Branch (TCB), should be available whenever air concentrations exceed 5 parts per million for greater than one hour.

MEDICAL CONTROL Workers exposed to sulfur dioxide should receive yearly lung function tests. Individuals who show a progressive loss of lung function should have exposure to sulfur dioxide reduced or eliminated.

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CYANIDES

HAZARD CLASSIFICATION EXTREMELY TOXIC

GENERAL Hydrogen cyanide, a gas also known as hydrocyanic acid gas or prussic acid gas, is formed when acids come in contact with cyanides or solutions containing cyanide. It has a faint odor of almonds.

The gas, frequently formed by dropping "cyanide eggs" into an acid solution, has been used extensively for fumigating ships, buildings, and greenhouses. Related compounds, such as cyanogen chloride, have also been employed for this purpose. Large amounts of cyanide solutions are used in electroplating various metals, such as gold, silver, zinc, copper and cadmium. Molten salts consisting mainly of sodium cyanide are used for case hardening steel articles.

HARMFUL EFFECTS Ingestion of cyanide or breathing concentrated fumes of hydrogen cyanide may be followed by death within a few seconds if large amounts of the gas are involved. In less acute cases headache, dizziness, palpitation and constriction of the chest occur, with weakening of the heart and death within a few hours unless proper treatment is applied.

Some investigators believe that long-continued exposures to small amounts of cyanide may produce symptoms of chronic poisoning.

Sodium cyanide which has a strongly alkaline reaction is very irritating to the skin, producing a cyanide dermatitis. Exposure to an alkaline cyanide spray may produce nose bleeding and ulceration of the nasal mucous membranes.

MAXIMUM ALLOWABLE CONCENTRATION For occupational exposure, the Maximum Allowable Concentration is 10 p.p.m. if the cyanide is present as hydrogen cyanide gas; 5 milligrams per cubic meter if the cyanide is present as alkali cyanide.

PROTECTIVE MEASURES Great care must be taken to prevent cyanide solutions from coming into contact with acids. Operations which give off hydrogen cyanide or a spray of cyanide droplets should be hooded and adequately exhaust ventilated. Good personal hygiene should be observed, including frequent washing of hands and arms and a change to clean work clothing. Where trouble is experienced with cyanide dermatitis, a protective barrier cream may be advisable. Gloves and face shields may be recommended for some operations. Requirements for local exhaust ventilation for plating tanks are described in Ventilation Data Sheet No. 2.

MEDICAL CONTROL Any worker presenting symptoms of cyanide poisoning should be given the following first-aid treatment.* Carry patient to fresh air. Have him lie down. Remove contaminated clothing but keep patient warm. Start the following first aid treatment immediately and CALL A PHYSICIAN.

If patient is conscious and breathing:

(1) Break an amyl nitrite pearl in a cloth and hold lightly over the nose for not more than 15 to 20 seconds. Repeat every five minutes for 25 minutes if recovery is not forthcoming.

(2) If cyanide has been swallowed, give patient one pint of 1 percent sodium thiosulfate solution (or soapy water or mustard water) by mouth every 15 minutes until vomiting occurs.

*Manual Sheet SD-30, Manufacturing Chemists' Association, Inc.

If patient has stopped breathing:

Break an amyl nitrite pearl in a cloth and hold lightly over nose for not more than 20 seconds, repeating every five minutes for 25 minutes or until breathing starts. Use artificial respiration but not mouth-to mouth resuscitation.

If patient is unconscious but breathing:

Break an amyl nitrite pearl in a cloth and hold lightly over nose for not more than 20 seconds, repeating every five minutes for 25 minutes if recovery is not forthcoming. Give oxygen from an inhalator.

Never give anything by mouth to an unconscious person. In all cases keep the patient quiet and warm until a physician arrives.

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*Manual Sheet SD-30, Manufacturing Chemists' Association, Inc. These first aid measures should only be carried out by nurse or certified emergency medical technician following the written medical directives of a physician.

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ORGANIC ACETATES

HAZARD CLASSIFICATION *FLAMMABLE* - Slightly toxic to moderately toxic and irritant. Use with reasonable precautions.

GENERAL The esters of acetic acid are widely used in lacquers which contain cellulose nitrate or acetate. They are not highly toxic, but the higher boiling members are quite irritant.

HARMFUL EFFECTS Methyl, ethyl and propyl acetate are mildly narcotic. Methyl acetate is metabolized, in part at least, to methanol and hence may produce the same effects as methanol. Butyl, amyl and hexyl acetates are more strongly narcotic than the lower esters and are also definitely irritating to the upper respiratory passages.

MAXIMUM ALLOWABLE CONCENTRATION

Compound	Parts per Million
Methyl acetate	200
Ethyl acetate	400
Propyl acetate	200
n-Butyl acetate	150
Sec-Butyl acetate	200
Tert Butyl acetate	200
Amyl acetate	100
Hexyl acetate	50

PROTECTIVE MEASURES Reasonable ventilation should be supplied to all areas where these esters are used, in order to keep the vapor concentration below the maximum allowable level. Compliance with local and state regulations regarding the handling of flammable liquids should be observed.

MEDICAL CONTROL Any exposed worker who shows dizziness, faintness or marked upper respiratory irritation should be removed from the site of exposure, if possible, into the open air and medical attention obtained as soon as possible.

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TOLUENE

HAZARD CLASSIFICATION MODERATELY TOXIC, flammable.

GENERAL Toluene (toluol) is a volatile, colorless liquid with a sharp odor. It is used as a solvent for resins and gums and as a diluent for lacquers and other coatings.

HARMFUL EFFECTS Acute poisoning, resulting from relatively brief exposure to high concentrations of toluene vapor, produces fatigue, mental confusion, exhilaration, dizziness, weakness and other symptoms of narcosis. Lower concentrations may produce irritation of the skin and eyes, ears, nose and throat.

Chronic poisoning is not well defined, but enlargement of the liver and slight blood changes have been reported in workers exposed to toluene. A defatting dermatitis is associated with prolonged exposure to the skin.

MAXIMUM ALLOWABLE CONCENTRATION For occupational exposure--100 parts of toluene per million parts of air.

PROTECTIVE MEASURES Ventilation, preferably by means of local exhaust, should be provided whenever toluene is used. The concentration of toluene vapor in the environment can be determined by air analysis, and the exposure of the worker to toluene can be measured by urine analysis. Absorption of toluene results in an increase in hippuric acid in the urine. Levels of this metabolite above seven grams per liter in end-of-shift samples is indicative of excessive exposure to toluene.

Whenever workers enter a tank or confined space which contains or has contained toluene, they should be required to wear life lines and hose masks or airline respirators approved by the National Institute for Occupational Safety and Health (NIOSH). An assistant with a prearranged emergency procedure should be stationed outside the confined space.

NIOSH approved gas masks may be used for emergency purposes for short exposure periods. The proper gas mask canister is black or black with a gray stripe. Canisters should not be re-used. The service life of a canister is approximately 25 minutes. The canister should be replaced during use if (1) any leakage is detected by smell or irritation, (2) high breathing resistance develops, (3) a window indicator (when present) shows a specified color change, or (4) the shelf life is exceeded.

A self-contained oxygen-breathing apparatus approved by NIOSH may be used in atmospheres containing high concentrations of toluene. Before heat is applied for the purpose of welding or cutting a vessel which has contained any toluene, complete removal of all toluene should be confirmed to prevent fire or explosion.

Since some commercial toluenes, especially those derived from coal tar, may contain significant amounts of BENZENE (see Chemical Data Sheet No. 3), an analysis of benzene concentration should be obtained for any commercial toluene; and if supplier or source changes, a new analysis should be made.

MEDICAL CONTROL Any worker suffering from acute toluene poisoning should be removed to fresh air immediately and a physician should be summoned.

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PERCHLOROETHYLENE

HAZARD CLASSIFICATION HIGHLY TOXIC - Use with caution

GENERAL Perchloroethylene (CAS #127-18-4), is also referred to as "perc", tetrachloroethylene, carbon dichloride, and ethylene tetrachloride. It is a heavy, colorless liquid with an odor similar to that of ether or chloroform. It is nonflammable and of relatively low volatility.

Its principal uses in industry are as a dry cleaning solvent (75% of all industrial use), a metal degreaser (7%) and a chemical intermediate in the production of fluorocarbons (8%). In addition, it is used as a solvent for fats, resins, and cellulose acetate. It can be found in some adhesives, paints, aerosols, and coatings.

HARMFUL EFFECTS Perchloroethylene has been shown to cause cancer in laboratory animals. Although carcinogenicity in humans has not yet been established, the National Institute for Occupational Safety and Health (NIOSH) recommends that perchloroethylene be treated as a potential human carcinogen.

Besides the possibility of cancer, perchloroethylene has the following toxic effects:

Acute poisoning results from the inhalation of high concentrations of the vapor, especially in confined spaces. Exposures to perchloroethylene at levels above 75 ppm has caused irritation of the eyes, nose, and throat. The solvent has a noticeable odor at 50 ppm which may not be distinguished after prolonged exposure.

In concentrations beginning at 100 ppm perchloroethylene may affect the central nervous system in ways similar to alcohol. It can cause lightheadedness, a feeling of being "high", headaches, fatigue, irritability, confusion, dizziness, slurred speach, nausea, vomiting, diarrhea, and loss of balance and coordination. All of these symptoms can increase the chances that an accident will occur. Symptoms become more noticeable and more serious at higher exposure levels. The effects of perchloroethylene and alcohol are additive, therefore drinking alcohol during or within a few hours of exposure to perchloroethylene will increase the severity of the symptoms.

Concentrations above 500 ppm may cause tremors, narcosis, convulsions, and pulmonary edema. If the worker is not removed from the site of exposure, unconsciousness and death may occur. In non-fatal cases, liver and kidney damage may occur. Concentrations this high are most likely to be reached in a tank or other confined space.

Chronic poisoning can occur when the worker has repeated or prolonged exposure to perchloroethylene, from months to years. In these cases, exposure may cause impaired memory and depression of the central nervous system which may be irreversible. Liver and kidney damage may also result from chronic exposure. Repeated or prolonged skin contact may produce dermatitis, with blistering and cracking of the skin.

In one case report perchloroethylene has been found to contaminate breast milk. Pregnant rat inhalation studies reported musculoskeletal abnormalities, fetoxicity, and behavioral effects in the newborn (National Toxicology Program). Therefore, pregnant and nursing women should avoid exposure to perchloroethylene.

OCCUPATIONAL EXPOSURE LIMITS

OSHA: The permissible exposure limit (PEL) to perchloroethylene is 100 parts per million parts of air (ppm) based on a time-weighted average concentration for an 8-hour work day. The OSHA ceiling limit is 200 ppm; this level may not be exceeded for any period of time.

NIOSH: NIOSH recommends limiting exposure levels to perchloroethylene to 50 parts per million averaged over a 10-hour work day. It also recommends that a ceiling of 100 ppm be implemented.

ACGIH: The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a threshold limit value (TLV) for perchloroethylene of 50 ppm averaged over an 8-hour work day with a ceiling limit of 200 ppm.

ODOR THRESHOLD The odor threshold for perchloroethylene is reported to range between 5 and 50 ppm. After prolonged exposure, the odor can diminish. Because of the wide range of individual sensitivity and the fact that "olfactory fatigue" may occur, detection by odor is not a dependable method for determining exposure level. However, an uncomfortable odor may be cause for concern that exposure is beyond the legal limit.

PROTECTIVE MEASURES

1. Maintenance: When used as an industrial degreasing agent or for dry cleaning, perchloroethylene should be used only in equipment appropriately designed, properly operated and carefully maintained. A routine inspection program to detect leaks in dry cleaning equipment should be followed. Any leaks should be repaired immediately. For further information regarding control measures for vapor degreasers, refer to the bulletin entitled, "The Safe Operation of Vapor Degreasers".

2. Engineering Controls: Proper ventilation systems, especially local exhaust ventilation, should be installed in the workplace to reduce and maintain employee exposure below the permissible exposure level. In dry cleaning, local exhaust vents should be located at the point of transfer or at the breathing zone, rather than at floor level. The exhaust from charcoal absorbers should be vented to the exterior of the building according to DEQE requirements. An adequate supply of fresh air should always be circulating throughout the area. Air analysis of the breathing zone around equipment should be conducted whenever doubt exists about vapor concentration.

3. Work Practices: In dry cleaning establishments, perchloroethylene exposure can be minimized by transferring garments as quickly as possible and by closing the dryer door immediately after the transfer. The use of dry-to-dry systems, in place of separate washers and dryers, will eliminate the transfer step entirely and thus further reduce worker exposure.

Gloves that are resistant to perchloroethylene should be worn in operations involving garment transfer, cleaning of button and lint traps and spot cleaning. Examples are gloves made of nitrile rubber or those coated with polyvinyl alcohol.

4. Safe Use, Handling and Storage: Perchloroethylene should be stored in metal drums or cans and safeguarded against sunlight. The solvent should be transferred to machinery by pumping through piping connected directly to the small opening of the drum. Transferring by hand or using open buckets must be avoided. In addition, perchloroethylene and its vapors should not be allowed to come in contact with open flames, sparks (as in welding), hot metal surfaces, electric arc or ultraviolet radiation, because the decomposition products, phosgene and hydrogen chloride, are highly toxic.

Whenever workers enter a tank or confined space which contains or has contained perchloroethylene, they should be required to wear life-lines and air-supply respirators approved by NIOSH.

An assistant with a prearranged emergency procedure should be stationed outside the confined space. Oil-proof rubber boots, gloves, and aprons should be provided. A lanolinated salve or lotion should be applied to the exposed skin to control irritation from and absorption of the solvent.

5. Respiratory Protection: For continuous exposures at levels greater than 500 ppm, NIOSH recommends the use of an approved self-contained breathing apparatus with a full face piece. An approved air-purifying full face respirator (gas mask) with a chin-style or a front or back mounted organic vapor canister may be used for very short term emergencies and other short exposure periods. The canister should be replaced IMMEDIATELY during use if leakage is detected by smell or irritation or if breathing resistance develops.

Air samples can be taken to indicate the severity of exposure to perchloroethylene.

6. Warning Signs and Labels: Employers are required to post the following warning sign in a visible location on processing equipment and on perchloroethylene storage tanks or containers:

TETRACHLOROETHYLENE
(PERCHLOROETHYLENE)

CAUTION

BREATHING VAPOR MAY BE
HAZARDOUS TO HEALTH

Keep containers closed when not in use.
Use only with adequate ventilation.
AVOID CONTACT WITH SKIN

May generate toxic gases on contact
with ultraviolet light, open flame, hot
surfaces, or other heat producing conditions.

7. Training: The Massachusetts Right to Know Law and OSHA regulations require that employers provide information and training to all covered employees who are exposed to perchloroethylene. The training should include information on health hazards and on safe handling practices.

EMERGENCY FIRST AID

Skin contact: Contaminated clothing and shoes should be removed immediately. Affected areas should be washed with soap and large amounts of warm water for approximately 15-20 minutes. SEEK MEDICAL ATTENTION IMMEDIATELY. CALL POISON CONTROL FOR ASSISTANCE: 232-2120 (BOSTON) OR 1-800-682-9211.

Eye contact: Eyes should be washed immediately with large quantities of water, occasionally lifting upper and lower lids, until no evidence of chemical remains. SEEK MEDICAL ATTENTION IMMEDIATELY. CALL POISON CONTROL FOR ASSISTANCE: 232-2120 (BOSTON) OR 1-800-682-9211.

Ingestion: Do not induce vomiting. SEEK MEDICAL ATTENTION IMMEDIATELY. CALL POISON CONTROL FOR ASSISTANCE: 232-2120 (BOSTON) OR 1-800-682-9211.

MEDICAL SURVEILLANCE NIOSH recommends that workers likely to be exposed to greater than 25 ppm as a time-weighted average should receive preplacement physical examinations, giving special attention to the neurological and cardiovascular systems, liver functions, and skin condition. Annual medical examinations are also recommended.

A worker with any health effects or symptoms that she/he thinks may be related to solvent exposures at work should immediately report these symptoms to her/his physician. A complete work history and description will aid in diagnosing the condition and its cause.

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BERYLLIUM

HAZARD CLASSIFICATION HIGHLY TOXIC - USE EXTREME PRECAUTIONS WHEN DUST OR FUME IS PRESENT

GENERAL Beryllium occurs naturally in the mineral beryl, a beryllium aluminum silicate. Metallic beryllium in a pure state is employed in guidance control and optical instrumentation, propulsion (solid rocket fuel) structures, X-ray tube windows and certain other nuclear and scientific applications,

Copper-beryllium and other alloys containing up to 5% beryllium are being extensively used for a variety of industrial purposes in automotive products, computers and business machines, electronics, process industries, communication, aerospace, power distribution equipment and in tools and special equipment.

Beryllium oxide is a good conductor of heat and an electrical insulator. It is used in the manufacture of ceramics, in parts for the electronics industry, crucibles and thermal coatings. It finds applications in the nuclear industry and in special individual plastics.

Special beryllium compounds find a minor use in intermetallic compounds, such as organics and chemicals. At one time it was an ingredient of the coating in fluorescent tubing employed for lamps and signs.

The biologically most active beryllium compounds are water-soluble salts, such as the sulfate and the fluoride. Dust and fumes from beryllium metal, beryllium alloys and finely divided beryllium oxide are also harmful. As far as is known, there is little hazard associated with the handling of the naturally-occurring beryllium mineral beryl.

HARMFUL EFFECTS (1) PULMONARY

(A) Acute. A relatively brief exposure to high concentrations of beryllium dust or fume may be followed by chemical pneumonitis, with symptoms of sudden shortness of breath, cough, cyanosis, fever, chest pain and an X-ray picture resembling pneumonia. The onset, depending on magnitude of exposure, may range from three days to several weeks after exposure. This acute form of the disease, if not fatal, subsides usually in one to six months. If the worker returns to the same occupational environment, recurrent episodes may ensue.

(B) Chronic. Beryllium is an eye, skin and mucous membrance irritant, skin sensitizer and pulmonary irritant. It is highly toxic by inhalation, intravenously or intratracheally. Poisoning affects the lungs, liver, kidneys, spleen and heart.

In the chronic or delayed form ofthe illness, the symptoms may develop at any time from a few months to years after the last exposure. The onset is gradual, with loss of weight, loss of appetite, chest pain, weakness, shortness of breath and cough. Delayed onset is often precipitated by some acute stress, such as pregnancy, viral respiratory infections or surgery. X-ray films will show a characteristic pattern of nodular changes. The course is protracted and usually progressive even after exposure ceases. Death in those severely affected and not properly treated follows a period of progressive weight loss, shortness of breath and heart failure.

Beryllium metal and beryllium oxide are positive animal carcinogens (IARC, WIP); suspect human carcinogens (IARC, WIP). These chemicals produced lung tumors in rats exposed intratracheally or by inhalation and bone cancer in rabbits by intravenous or intramedullary routes. Studies show a slightly increased risk of lung cancer in occupationally exposed white males.

(2) SKIN. Skin lesions caused by beryllium and certain of its compounds are:

(A) Contact dermatitis and skin ulcers.

(B) Subcutaneous granulomas resulting from beryllium particles penetrating the skin appear as localized small tumors which disappear when the foreign material is removed.

MAXIMUM ALLOWABLE CONCENTRATION — For continuous exposure over an eight-hour period--two micrograms (0.002) milligram) beryllium per cubic meter of air.

PROTECTIVE MEASURES — All operations giving off dust or fume of beryllium or its compounds should be enclosed or supplied with effective local exhaust ventilation.

Handling of beryllium or beryllium powder should be done in a booth ventilated at not less than 200 cfm. per square foot of opening. If noticeable dust is produced, an enclosed dry box should be used if practicable.

Employees must wear appropriate protective (impervious) clothing and gloves to prevent any possibility of skin impact with this substance.

Although the melting of copper-beryllium alloy produces very little beryllium fume, a ventilated hood over the furnace is recommended.

High-speed machining operations with beryllium at cut-off wheels, surface grinders and centerless grinders should be enclosed as much as possible and exhaust ventilated at not less than 200 cfm. per square foot of opening.

Milling, drilling, polishing and similar machining operations of beryllium should be provided with local exhaust ventilation so as to produce a control velocity of 150 fpm. at the point of operation. Beryllium alloys usually do not require special ventilation for machining operations, but dry grinding and polishing processes should be exhausted.

In the grinding of beryllium alloys, the grinding wheel should be hooded in accordance with the bulletin entitled, "Standard Hoods for Grinding, Buffing and Polishing," published by the Division. The air volumes exhausted should be at least 25% greater than those specified for regular grinding.

For operations of short duration involving exposure to beryllium dust, approved air-line respirators or filter-type respirators approved for use against highly toxic dust or fumes may be worn. Respiratory protective devices approved by the U.S. Department of Health and Human Services, National Institute of Occupational Safety and Health (NIOSH) or the U.S. Department of the Interior, Mining Enforcement and Safety Administration (MESA) should be used anytime the actual or projected exposure exceeds the standard until such exposure can be controlled by engineering practices.

The Federal Environmental Protection Agency has promulgated an emission standard for beryllium which restricts the amount of beryllium that can be released to the outside environment. This standard should be complied with in all instances when controlling in-plant beryllium emissions. The standard limits total atmospheric emissions to less than 10 grams in a 24-hour day and shall not permit an out-plant concentration of greater than 0.01 microgram per cubic meter of air over a 30 day period.

Respiratory protection should be used anytime the actual or projected exposure exceeds the standard until such exposure can be controlled by engineering practices.

Separate locker facilities should be maintained and separate work clothes worn so that nonwork clothing is not contaminated with beryllium.

Food preparation and eating should be prohibited in beryllium work areas.

MEDICAL CONTROL Personnel working with beryllium or its compounds should be under close medical supervision, with particular attention to lungs, skin and general health. Once berylliosis of the lungs has been recognized, removal from exposure and, where indicated, steroid therapy are required.

Comprehensive preplacement history and physical examination should be obtained and include a 14 inch by 17 inch chest X-ray, baseline pulmonary function tests (FEV_1 and FVC) and a baseline weight.

Annually each exposed worker should be given lung function tests (FEV_1 and FVC), a medical history questionnaire, including presence of respiratory symptoms, and a 14 in. by 17 in. chest X-ray.

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No. 1387 Supersedes No. 1182 June, 1986

METHYL CHLOROFORM

HAZARD CLASSIFICATION Slightly toxic--Nonflammable.

GENERAL Methyl chloroform, also known as 1,1,1 trichlorethane, is a colorless, volatile solvent with a pleasant odor detectable at 100 ppm.

It is widely used as a cold cleaner, especially for removal of oil, grease, tar, wax and adhesives, from machinery, type, appliances and electric motors and generators and as the solvent in vapor degreasers. It may be applied by wiping, dipping or spraying. It has replaced the much more toxic carbon tetrachloride and trichloroethylene for many cleaning operations.

HARMFUL EFFECTS Acute poisoning. Methyl chloroform has a narcotizing effect, and inhalation of high concentrations may result in impaired coordination, dizziness, sleepiness and unconsciousness. Slightly transient eye irritation may occur at 500 ppm.

Chronic poisoning has not been reported in humans. It would be expected to occur, if at all, only after repeated exposure to concentrations high enough to cause symptoms of acute poisoning.

Dermatitis. As with other solvents, prolonged and frequent contact may result in irritation of the skin.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure in an eight-hour working day -- 250 parts of methyl chloroform per million parts of air.

PROTECTIVE MEASURES Good general ventilation is adequate for small cleaning operations with methyl chloroform. Spray cleaning, cleaning large surfaces, cleaning at elevated temperatures and cleaning in confined spaces will require special precautions to avoid overexposure.

MEDICAL CONTROL Workers using methyl chloroform in large amounts should be supervised, and at the appearance of definite symptoms of anesthesia, removal to fresh air and attention by a physician are indicated. Exposure can be measured by analysis of methyl chloroform in expired breath collected in the immediate post-exposure period.

Note: Physicians attending cases of methyl chloroform intoxication should be aware that adrenalin and related compounds are contra-indicated in this condition.

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URANIUM

HAZARD CLASSIFICATION HIGHLY TOXIC AND SLIGHTLY RADIOACTIVE

GENERAL Natural uranium consists of three isotopes, with the following properties:

Isotope	Per Cent	Half-Life (Years)	Energy of Alpha Rays (MEV)
U^{238}	99.2	4.49×10^9	4.18
U^{235}	0.72	7.13×10^8	4.58
U^{234}	0.005	2.48×10^5	4.76

Enriched uranium contains more U^{235} and U^{234}, the amount depending on the degree of enrichment. These isotopes, U^{234} in particular, are more highly radioactive than U^{238}. The specific activity of natural uranium is approximately 0.7 microcurie per gram.

Uranium oxide and metallic uranium, either natural or enriched, are used in the fabrication of fuel elements for nuclear reactors. Natural uranium compounds are employed in the ceramic, chemical and metallurgical industries. **Depleted uranium is employed as counterweights in aircraft, radiation shielding, ammunition, weapons and gyrorotors.**

HARMFUL EFFECTS **Insoluble dust may be** retained in the lungs for long periods, **producing injury to that organ by** ionizing radiation. Lung cancer has been reported in uranium miners. Soluble dust is rapidly absorbed from the lungs but may cause kidney injury through chemical effect. Enriched uranium is much more radioactive than ordinary uranium and is therefore more hazardous.

Metallic uranium ignites readily (spontaneously if finely divided) and, when it burns, gives off toxic fumes of uranium oxide.

MAXIMUM PERMISSIBLE DOSE

External	Whole body, Gonads, lens of eye, Head and trunk, Active blood-forming organs	1.25 rems in any calendar quarter
	All organs, including thyroid, other then those above	**5.0 rems in any calendar quarter**
	Skin of whole body, Thyroid	7.5 rems in any calendar quarter
	Hands and forearms, Feet and ankles	18.75 rems in any calendar quarter

Exposure of the Fetus of Fertile Women

During the entire gestation period, the maximum permissible dose-equivalent to the fetus from occupational exposure of the expectant mother shall not exceed 0.5 rem.

Internal Total body burden - soluble compounds - 0.2 microcurie

- insoluble compounds - 0.009 microcurie

MAXIMUM PERMISSIBLE CONCENTRATION Atmospheric A maximum concentration of 50 micrograms per cubic meter of air is recommended for either soluble or insoluble compounds. The radioactivity due to the airborne dust should not exceed 7×10^{-5} microcuries per cubic meter of air.

PROTECTIVE MEASURES The dust should be controlled at the point of origin by the use of local exhaust systems or wet methods. The operation dispersing the dust should be isolated or enclosed. Frequent monitoring of the atmosphere for alpha-emitting dust may be advisable. Respirators of a type approved for toxic dusts may be necessary for some operations.

Note: In handling and storing enriched uranium, care must be taken that a critical mass is not formed, resulting in spontaneous fission and the evolution of intense radiation. While 80 lbs. of U^{235} in the form of massive metal can be stored safely, the minimum critical mass for a U^{235} salt in aqueous solution is less than two pounds.

There is virtually no danger of criticality from natural uranium.

In the machining of metallic uranium, care must be taken to prevent ignition of dust and chips. When the chips are wet with mineral oil, ignition is unlikely.

MEDICAL CONTROL General - Employees exposed to radioactive material are subject to regulations which require the keeping of medical records, pre-employment examinations with special emphasis upon previous exposures, skin, eyes and lymphatic tissues, blood counts, yearly checkups and final examination upon termination of exposure (See Bulletin No. 1143.) In case of overexposure immediate medical attention, close follow up for a prolonged period of time, and temporary removal from further exposure are indicated.

Specific - Individuals with kidney disorders should not be exposed to uranium dust or fume.

The concentration of uranium in the urine should not exceed 50 micrograms per liter of 5×10^{-5} microcuries (110 disintegrations per minute) per liter, whichever is the lower. Higher levels may be tolerated for brief periods, however.

REGISTRATION Quantities of uranium in excess of the following exempt possession limits are required to be registered with the Massachusetts Department of Labor and Industries in accordance with the provisions of Industrial Bulletin No. 5, "Rules and Regulations..... Ionizing Radiation," dated December 15, 1978:

Exempt Possession Limits	Unsealed (Microcuries)	Sealed (Microcuries)
Uranium (natural)	500	500
Uranium 233 (U 233)	0.1	1
Uraniun 234 - 235 (U 234 - U 235)	1	10
Uranium depleted (U 238)	500	500

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No. 1255 Supersedes No. 1165 January, 1983

BUTYL ALCOHOL (N-BUTANOL)

HAZARD CLASSIFICATION Moderately irritant and toxic; combustible. Use with reasonable precaution.

GENERAL Butanol is a colorless liquid with a distinct diagreeable odor, similar to that of fusel oil. It is used as a solvent or diluent in lacquers, plastics, safety glass, airplane dopes, perfumery, cosmetics, paint and varnish removers, and as a denaturant for ethyl alcohol.

HARMFUL EFFECTS The chief symptoms of butanol intoxication are irritation of the respiratory passages and eyes, dermatitis, and cough. Butyl alcohol also causes inflammation of the eyes, lachrymation, corneal damage, as well as unusual keratitis. Although systemic effects, i.e., liver, blood have been noted in animals, no similar findings have been reported in industrial workers. Exposures in excess of 50 ppm. are associated with irritation of eyes, and its odor is objectionable. These properties serve as warnings against overexposure.

MAXIMUM ALLOWABLE CONCENTRATION 50 parts of butanol per million parts of air.

PROTECTIVE MEASURES Lacquer spraying, dipping and coating operations should be provided with local exhaust ventilation. As a rule, good general ventilation is adequate for lacquer mixing, manual cementing, and similar processes. If excessive concentrations of vapor are present, the eyes as well as the respiratory passages should be protected.

MEDICAL CONTROL Short exposure to high concentrations of the vapor may cause conjunctivitis or even keratitis, eye conditions which require medical attention. Mild skin irritation of the fingers has been observed after prolonged exposures, and this may require appropriate treatment.

NOTE: The isomers of n-butanol, isobutyl alcohol, secondary butyl alcohol, and tertiary butyl alcohol, are used less extensively. Animal studies indicate toxicities of the same order as that of n-butanol, but no ill effects have been reported in humans from their industrial use.

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PARATHION

PARATHION is the common name of the liquid known chemically as 0,0-diethyl O-p-nitrophenyl thiophosphate. It is one of a class of chemicals called organic phosphates, some of which, such as PARATHION, are highly toxic. It has been found to be one of the most effective insecticides known for the control of many agricultural and horticultural pests. For application in the field, it is highly diluted, either as a dust or as a water dispersion of a wettable powder.

HAZARDS Skin contact with the liquid or with impregnated dusts must not be permitted, and inhalation of the diluted dusts, mists, aerosols, or sprays must be avoided. Symptoms of poisoning include headache, shortness of breath, tightness of the chest, pinpoint pupils, giddiness, nausea and diarrhea or related symptoms. Severe exposure may lead to pulmonary edema.

MAXIMUM ALLOWABLE CONCENTRATION For occupational exposure - - 0.1 mg. per cubic meter of air.

MEDICAL CONTROL Workers handling PARATHION formulations who develop symptoms described above should be seen by a physican immediately and treatment begun as soon as possible.

Medical treatment consists in the application of drugs which counteract the depletion of cholinesterase, with its nicotine-like effect upon the human body.

Specific measures are:

1. Contaminated clothing should be removed and contaminated skin areas washed with soap and water.

2. Atropine in large and repeated doses should be given, with the proper dose to be determined by the attending physician. Wherever evidence of serious poisoning exists, atropine sulfate may be given by mouth or injection in doses of up to 2 milligrams every half hour without fear of overdosage.

3. Cholinesterase reactivators, such as PAM (Protopam chloride, from Ayerst Pharmaceuticals, Inc., 4000 Hadley Rd., So. Plainfield, NJ 07080, telephone 800-631-5331), are now commercially available. Given intramuscularly or intravenously in repeated doses of 1 gram each, they are of considerable value if given early, but this medication must be combined with atropine.

4. Special care must be taken to improve impaired respiration by the use of a resuscitator, positive oxygen-pressure apparatus and, in extreme cases, tracheostomy or use of an endotracheal tube.

Medical Surveillance:

A red cell and plasma cholinesterase test should be performed when parathion poisoning is suspected. The red cell cholinesterase activity of adults with symptoms, as measured by the Michel method, is usually reduced to below 0.20 ΔpH/hr and close to zero in severe poisoning. The normal range is wide, with an average of about 0.77 ΔpH/hr for red cells (range 0.39 - 1.02) and average of 0.95 ΔpH/hr for plasma (range 0.44 - 1.63).

Red cell cholinesterase reflects the initial clinical state of the patient at the time he comes in for medical care, but plasma cholinesterase does not. Plasma cholinesterase is a more sensitive and more rapid indicator of exposure.

Whole blood cholinesterase screening tests can be useful in an emergency, particularly when there is a delay because the standard laboratory test is not available locally. They should be followed by a standard red cell and cholinesterase test in the laboratory wherever possible.

In very severe poisoning in which the victim was unconscious for some time, brain damage from anoxia has occasionally been reported. Otherwise, clinical recovery is usually complete with a few days.

However, cholinesterase activity, even when the drug 2-PAM has been used, may require a longer period to return to normal. Red cell cholinesterase may take several months to return to normal after reaching zero; plasma cholinesterase recovers more rapidly. Both may "rebound" to above normal level after recovery.

CONTROL MEASURES (AGRICULTURAL)

1. The conditions under which PARATHION insecticides are handled in the field are entirely different from those under which large quantities are handled daily in plant processing. Nevertheless, careful handling and precautionary measures should be followed.

2. PARATHION formulations in field applications should be limited to recommended percentages of dust and to not more than 25% PARATHION wettable powder. Transferring and mixing should be done in the open air or in well-ventilated quarters.

3. Workers exposed to PARATHION dust or sprays should each day don clean underwear, socks, overalls and caps, and should use dust respirators having a time weighted average of less than 0.05 mg. per cubic meter or respirators especially designed for PARATHION approved by the U.S. Department of Labor, National Institute for Occupational Safety and Health (NIOSH).

4. Persons engaged in field applications should, at the end of work, take showers, washing thoroughly with soap and water, and change to clean clothes.

5. Food should be kept away from dusting or spraying areas, and workers should wash before eating or smoking.

6. Care should be exercised in the disposal of containers that have been used for PARATHION formulations. Paper bags should be burned.

7. Pilots engaged in the airplane application of dry dust formulations should wear personal protective equipment and observe the precautions recommended for ground workers.

8. Pilots should make sure that the motor is off while loading. The dust flow from the plane should emerge well behind the pilot, and on return trips dust clouds should be avoided. Goggles and a half-mask or full-face mask should be worn while dusting or spraying.

PREVENTION

DETECTION **EVALUATION**

CONTROL

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No. 1347 Supersedes No. 1334 March, 1983

ISOCYANATES

HAZARD CLASSIFICATION HIGHLY TOXIC AND IRRITATING. USE WITH RIGOROUS PRECAUTIONS.

GENERAL These substances range from colorless to pale yellow liquids with a distinct penetrating odor.

The odor threshold for toluene di-isocyanate is reported to be 0.3 to 0.4 ppm., but particularly sensitive persons will experience eye irritation and tearing at much lower levels.

The isocyanates in common use are organic compounds and may be either aliphatic or aromatic. The chief ones are as follows:

(1) Toluene Di-isocyanate (TDI)
(2) Diphenylmethane Di-isocyanate (MDI)
(3) Polymethylene Polyphenyl Isocyanate (PAPI)
(4) Hexamethylene Di-isocyanate (HDI)
(5) Naphthalene Di-isocyanate (NDI)
(6) Methylene Bis (4-cyclohexylene) isocyanate

All have been reported to cause respiratory symptoms; however, MDI, NDI, and PAPI, because of their lower volatility, have not been found to be so troublesome as TDI.

The main industrial use for the isocyanates is in the manufacture of polyurethane foams; but they are also employed in a wide range of products, such as cushions, crash panels, insulation, paints, and protective coatings. When the yellowing characteristics of aromatic isocyanates are undersirable, the aliphatic isocyanates are employed.

HARMFUL EFFECTS Acute effects. Vapors can cause severe irritation of the mucous membranes, thus leading to initial symptoms of burning of the eyes, congestion of the nose, dry sore throat and throbbing headache. Dry cough with chest pain or tightness often follows and can occur hours after exposure. An asthma-like syndrome may develop and, in severe cases, proceed to status asthmaticus and death.

Chronic effects. Repeated exposure may produce a chronic asthma-like syndrome. Workers frequently complain of symptoms, often at night, including coughing, a tightness or congested feeling in the chest, and shortness of breath. Excessive chronic loss of pulmonary function has been reported when excessive TDI exposure continues.

MAXIMUM ALLOWABLE CONCENTRATION For continuous occupational exposure to isocyanate--0.005 ppm.

PROTECTIVE MEASURES 1. Where environmental control is possible. Complete enclosure of the system or adequate local exhaust ventilation should be used. On all process equipment, the ventilating system should be electrically or pressure interlocked so that it will be necessary to operate the exhaust fans to start and continue the processing operation. Isocyanate storage areas are frequently sources of heavy contamination and should also be adequately ventilated.

2. Where environmental control is not possible. In spray and inadequately ventilated applications, personal respiratory protection should be used, as well as protective clothing, gloves, and face shields.

Respiratory protection should be full-face masks approved by the U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, (NIOSH), Testing and Certification Branch (TCB). Suitable types are listed below. The first two types of respiratory protective devices are recommended for large spills or high concentrations of isocyanates; gas masks are recommended only for small spills and should be used only as an emergency measure.

Protective Equipment List

Demand or constant flow air-line respirator with full face-piece
Self-contained breathing apparatus
Canister gas mask (full face)

Approved gas masks may be used for emergency purposes. The proper gas mask canister is yellow with a gray stripe around the top. Canisters should not be re-used. The service life of a canister is approximately 25 minutes. The canister should be replaced during use if (1) any leakage is detected by smell or irritation, (2) high breathing resistance develops, (3) if a window indicator (when present) shows a specified color change, or (4) if shelf life is exceeded.

3. Control of spillages. In the event of isocyanate spillages, the area should be cleared of all personnel promptly. Those engaged in removing the spill should wear a suitable respirator or gas mask, boots and gloves. An absorbent material, such as sawdust, in excess of the amount necessary to absorb the isocyanate, should be spread on the spillage. A 5% aqueous solution of ammonia estimated at twice the volume of TDI spilled should be poured into the absorbent material. After it has been absorbed thoroughly, the contaminated material should be swept into a polyethylene bag and the waste removed to an outside location for disposal.

Fires involving raw TDI or products in which the chemical is used give rise to toxic vapor; therefore, all persons engaged in fire fighting should be aware of this danger and be instructed in the necessity of using self-contained breathing apparatus.

MEDICAL CONTROL Preplacement examinations should be given to prevent exposure of employees with chronic respiratory illnesses and allergies. Pre-employment medical examinations should include the following: (1) History of smoking habits and respiratory symptoms (breathlessness, cough, wheezing, shortness of breath, tightness in the chest, nocturnal symptoms), (2) Chest X-ray on full-size film, (3) Pulmonary function tests (vital capacity and forced expiratory volume), and (4) White cell, differential, and total eosinophil counts.

Periodic examination at least annually should include all of the above with the exception of the chest X-ray. An estimate of the FVC and FEV at the beginning and end of a work shift, within the first six months of work with isocyanates, is recommended to detect isocyanate reaction.

Workers suffering from acute overexposure should be removed from the work area immediately and taken directly to a physician or hospital for prompt medical attention.

Workers developing respiratory symptoms or showing greater than expected lung function loss over a single day or over a period of time should be removed from exposure to isocyanate vapor and should be seen by a physician promptly.

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No. 1316 Supersedes No. 1268 April, 1982

EPOXY RESINS

HAZARD CLASSIFICATION TOXIC - Use with care.

GENERAL Epoxy resins are widely used in re-inforced plasties, chemical resistant coatings, adhesives, and electrical and electronic components. They are among the toughest and most chemically resistant plasties and have very high electrical resistance. Most epoxies are prepared in situ by mixing an epoxy component and a hardener or curing agent. It is the latter materials which produce most of the adverse reactions observed in the use of epoxy resins.

HARMFUL EFFECTS Skin reactions are usually caused by uncured resin compounds; fully cured resins are generally harmless.

1. Primary irritation. Redness, itching, swelling, blisters, oozing, crusting and scaling occur on areas of the skin which have been in direct contact with the resin. The face, neck, forearms and hands are most commonly affected.

2. Allergic sensitization. Many people become allergic to epoxy resin components. A severe type of dermatitis often occurs over widespread areas of the body a week or more after the first contact. Swelling, redness, and oozing are present, and affected people frequently are not able to work.

3. Other conditions. The curing agents are frequently aliphatic polyamines and can cause asthma and other respiratory symptoms, nose and throat irritation, headache, nausea and intestinal upset. The eyes are also affected by the vapors or by direct contact.

ENVIRONMENTAL CONCENTRATIONS Ethylene diamine and diethylene triamine, with threshold limit values of 10 and 1 parts per million, respectively, are common curing agents. Other amines are also used, but threshold limit values have generally not been assigned. Epichlorohydrin is reported to be present in trace amounts but is not considered to be of harmful significance.

PROTECTIVE MEASURES Inhalation of vapors and mists and contact with the skin should be avoided. Workers should wear cotton-lined rubber gloves, protective creams, long-sleeved shirts, rubber aprons, and safety glasses. Vapors and mist should be removed from the workers' breathing zone by means of local exhaust ventilation. In some cases the use of full-face shields, respirators approved for organic vapors and ammonia, or air supplied full-face respirators may be needed. Workers should wash their hands and face frequently with a neutral or slightly acidic soap. Alkaline, powdered or abrasive cleansing agents, and organic solvents should be avoided. Workers should be made aware of the hazards of working with epoxy resins, the symptoms of exposure, and personal protective measures. Refer to bulletin, "Personal Hygiene in Handling Epoxy Resins," published by the Division.

MEDICAL CONTROL Persons with active skin conditions or respiratory allergies should be excluded from exposure.

Persons who become sensitized should be removed from further exposure.

Persons with skin or respiratory effects from exposure should be treated by a physician and removed from further exposure. Medical evaluation with pulmonary function testing should be undertaken on a once every three-year basis in high exposure areas.

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MASS MA13.2:R245

OZONE

HAZARD CLASSIFICATION HIGHLY TOXIC--USE WITH RIGOROUS PRECAUTIONS.

GENERAL Ozone is a colorless to pale blue gas with a characteristic pungent odor. Ozone is formed by electrical arcs and corona discharges in air or by ultraviolet photochemical reactions. It is generated by inert gas shielded arc welding, especially when argon is used. Ozone finds use as a water purifying agent for bleaching fluorocarbon polymer fibers, waxes, paper, flour, textiles and oils for treatment of industrial wastes; for sterilization of air; for deodorization of sewage and gases; and for preservation of food in cold storage.

HARMFUL EFFECTS The concentration immediately hazardous to life is unknown, but 50 parts per million of air for 30 minutes are expected to produce fatal results.

Welders who have had a severe acute exposure to an estimated 9 parts of ozone together with other air pollutants reportedly have developed pulmonary edema. Some of these workers continued to complain about fatigue and exertional dyspnea nine months later.

Inhalation of one to two parts per million for two hours produces headache, pain in the chest and dryness of the upper respiratory tract. Exposure at 0.5 part per million for three hours is suspected of enhancing susceptibility to respiratory infections.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure - 0.1 part ozone per million parts of air. Due to its radiomimetic nature (may affect the worker similarly to ionizing radiation), there is no true threshold--no exposure, however small, that is theoretically without effect.

PROTECTIVE MEASURES To obtain atmospheric concentrations below 0.1 part per million, enclosure and local exhaust ventilaion are the appropriate engineering technique.* The radiation from inert gas shielded arc welding can generate ozone several feet away from the weld, which necessitates careful shielding to block the ultraviolet rays. Persons unavoidably exposed to hazardous amounts of ozone should wear full facepiece airline respirators approved by the U. S. Department of Human Services, National Institute for Occupational Safety and Health (NIOSH).

MEDICAL CONTROL The onset of symptoms following exposure may be immediate or delayed. Significant exposures result in pulmonary auscultatory findings, such as wheezes, râles and rhonci, persisting 30 minutes or longer following removal from the contaminated atmosphere. Persons who suffer exposure to levels of ozone greater than one part per million for any prolonged period should be hospitalized, given oxygen and observed by a physician to watch for potential pulmonary edema, even if no acute symptoms are reported.

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*Please see bulletin, "Inert Gas-Shielded Arc Welding," No. 987

(Continued)

Pre-employment medical examinations should be conducted to exclude those with evidence of chronic respiratory disease from work in areas subject to extensive levels of ozone.

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No. 1366 Supersedes No. 1280 June, 1985

CHLORINE

HAZARD CLASSIFICATION HIGHLY TOXIC, IRRITANT

GENERAL Chlorine is a heavy, yellowish green gas or a clear, amber colored liquid with a pungent irritating odor. Because of its strong odor, chlorine has good warning properties to persons who come into contact with it. The major way by which chlorine is produced is the electrolysis of sodium chloride brine in either diaphragm or mercury cathode cells with chlorine being released at the anode. Chlorine is used in the production of chlorinated solvents, inorganic and organic chemicals, pesticides, herbicides, refrigerants, propellants, synthetic rubber and plastics; as a bleaching agent in the paper, pulp and textile industries; as a disinfectant in water and sewage treatment; and for the removal of tin and zinc from iron.

HARMFUL EFFECTS Acute. Chlorine in contact with moisture reacts to form hydrochloric acid. Heavy exposure causes severe damage to mucous membranes of the respiratory tract. Symptoms include burning sensation of the eyes, nose and throat, coughing, choking, nausea, vomiting, syncope, tracheobronchitis and pulmonary edema. Deaths have occurred. Skin burns have resulted from exposure to gaseous chlorine. Following acute exposure, an asymptomatic latency period of up to a few hours can occur before the sudden onset of acute pulmonary edema. For this reason it is recommended that heavily exposed persons be admitted to a hospital for close observation. Although some individuals will suffer permanent impairment of lung function following heavy accidental exposure, most will recover completely within a short time.

Chronic. Inhalation of low concentrations of chlorine gas over a long period of time may not result in permanent damage to the respiratory tract. Exceptions to this are individuals with a pre-existing respiratory disease which can be severely aggravated by even low levels of chlorine.

Excessive exposure to chlorine can also occur when solutions of hypochlorites are mixed with such materials as toilet bowl cleaners or vinegar. Maintenance and custodial personnel should be warned of this possibility. Chlorine exposure may also occur when chlorinated hydrocarbons are decomposed thermally or by ultraviolet radiation from electric arcs generated during welding operations.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure, 0.5 part of chlorine per million parts of air.

PROTECTIVE MEASURES Work and storage areas should be kept cool and well ventilated. Impervious gloves should be worn if the possibility of skin contact exists, such as during the handling and changing of chlorine cylinders. Impervious protective clothing and eye and respiratory protection should be kept in a convenient location for emergency use. Leak repair kits should be obtained and stored in a readily accessible location. Personnel should be trained in their use. Water should never be used to control leaks or spills.

MEDICAL CONTROL Persons who will be exposed to low levels of chlorine in the course of their work should be given pre-employment physical examinations which include a full-size chest film (14 in. x 17 in.). Persons with pre-existing respiratory diseases should be made aware of their increased health risk from exposure to low levels of chlorine.

Persons who have suffered heavy accidental exposure should be hospitalized and observed by a physician for symptoms of acute pulmonary edema. Because the onset of symptoms following acute exposure may be delayed in some cases, all such individuals should be observed carefully for a period of no less than 24 hours.

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No. 1261

April, 1983

STYRENE

HAZARD CLASSIFICATION MODERATELY TOXIC, HIGHLY FLAMMABLE.

GENERAL Styrene, also known as vinyl benzene, phenylethylene and cinnamene, is a colorless, volatile liquid with a penetrating aromatic odor which is detectable at less than 1 ppm. When heated or exposed to light or a peroxide catalyst, a rapid, exothermic polymerization reaction occurs which may become explosive. For this reason an inhibitor such as hydroquinone or butylcatechol is usually added. Styrene is used in the plastics industry as a cross-linking agent for polyester resins, as a copolymer in styrene-buta liene rubber and as the primary component for polystyrene plastics. It is widely used in the fabrication of fibrous glass reinforced plastics, including boat hulls, bathtubs, fishing rods, ladders, etc. Other important uses are bulk polymerization and injection molding of casings for household products, electrical appliances and toys.

HARMFUL EFFECTS Acute: Styrene, which is absorbed through the lungs and skin, causes eye and upper respiratory tract irritation. At high concentrations a condition known as "styrene sickness," consisting of nausea, headache, fatigue, dizziness and drowsiness, may occur.

Chronic: There is some evidence that respiratory effects such as chronic bronchitis and upper airway obstruction may develop after years of exposure.

Animal Experimentation: A long term National Cancer Institute study of laboratory animals given large doses of styrene and beta-nitrostyrene by oral gavage has yielded no evidence of cancer-causing activity (carcinogenicity) in rats or mice of either sex. Styrene oxide, a metabolite of styrene and a chemical used in making epoxy resins, is currently being tested. No data are presently available.

MAXIMUM ALLOWABLE CONCENTRATION For occupational exposure - 50 parts of styrene per million parts of air.

PROTECTIVE MEASURES To minimize the possibility of explosion, styrene should be stored away from heat and light in well ventilated areas which have been equipped with a sprinkler system and fire walls. When working with styrene employees should be provided with safety glasses or chemical safety goggles, gloves and disposable clothing including shoe coverings if there is a possibility that styrene might come into contact with skin or clothing.

Exposure to styrene vapor should be controlled by proper ventilation measures to fit the specific operation. Closed systems should be used whenever possible.

MEDICAL CONTROL Any worker who develops symptoms of "styrene sickness" should be removed to fresh air immediately. If skin contact has occurred, the skin should be washed with soap and water. Skin should not be washed with organic solvents or abrasive cleaners.

The degree of exposure to styrene may be determined by analyses of air for styrene and of urine samples for mandelic acid. Urine samples should be collected at the end of a work shift toward the end of the work week. Mandelic acid concentrations above the 800-1500 mg/1 level may be indicative of styrene exposure in excess of the TLV of 50 ppm, depending on analytical method.

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No. 1262 January, 1982

ANILINE

HAZARD CLASSIFICATION HIGHLY TOXIC - USE WITH CAUTION.

GENERAL Aniline is a colorless, oily, volatile, flammable liquid with an aromatic odor. Aniline is extensively used in the manufacture of aniline dyes, preparation of various pharmaceutical products, and as a solvent and accelerator in the rubber industry.

HARMFUL EFFECTS Acute poisoning, resulting when a large amount of vapors have been inhaled or clothes have been saturated with the substance, may cause convulsions, general tremors, irregular, slow respiration, rapid, feeble action of the heart, attacks of vertigo, headache, nausea, vomiting, and coughing. The mucous membranes of the mouth may be almost black. The exhaled breath has a strong odor of aniline. The neck is often rigid; the pupils dilated; the skin cold, insensitive, and covered with perspiration; and body temperature low. The patient may stagger, become delirious and have convulsions. Coma or death may follow.

Chronic poisoning. Symptoms are anemia, slow pulse, nausea, vomiting, headache, diarrhea, dizziness, muscular pains, ringing in the ears, and painful urination. A skin eruption of eczematous and pustular character may appear on the limbs as well as other parts of the body, especially after the clothing has been saturated with the liquid.

MAXIMUM ALLOWABLE CONCENTRATION For occupational exposure--5 parts of aniline per million parts of air.

PROTECTIVE MEASURES Ventilation should be provided in work areas where aniline is stored or handled. Local exhaust ventilation should be provided for the operations when aniline is used. Protective clothing and eye protection should be furnished and worn by the employees when working with the liquid.

Where possible, aniline and its compounds should be stored in closed receptacles fitted with tight covers.

Workroom floors should be kept clean and free from aniline or any of its compounds. Asphalt, tar, or other porous material should not be used for the floor, as they will absorb the aniline.

Food should not be kept or eaten in a room where aniline or its compounds are used or stored. The hands of the employees handling aniline or any of its compounds should be washed before eating or drinking.

Ample washing facilities, including plenty of warm water and soap, should be provided. Clothing which has become soiled with aniline should not be worn.

A supply of vinegar or 3% acetic acid should always be on hand in case of an aniline spill on the skin.

Employees handling aniline or any of its compounds should abstain from the consumption of alcoholic stimulants.

MEDICAL CONTROL In no case of aniline poisoning should the patient be given alcoholic stimulants. In all cases of aniline poisoning it is best to summon a physician without delay.

All employees using or handling aniline or any of its compounds should be physically examined at regular intervals by a physician familiar with the effects of aniline.

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XYLENE

HAZARD CLASSIFICATION: MODERATELY TOXIC, FLAMMABLE.

GENERAL Xylene, also known as dimethylbenzene or xylol, is a volatile, colorless liquid with a pleasant aromatic odor which is detectable at less than 20 ppm. Commercial grades exists as a mixture of meta, para and ortho xylene. The major source is from the fractional distillation of petroleum, coal tar or coal gas. It is widely used as a solvent for resins, lacquers, enamels and rubber cements, in fuels and in the synthesis of organic chemicals and dyes.

HARMFUL EFFECTS Acute: Exposure to high concentrations of xylene can cause narcosis with associated symptoms of fatigue, impaired judgment, dizziness and weakness. Lower concentrations can produce irritation of the skin and mucous membranes of the eyes, nose and throat. Cases of corneal damage and liver and kidney damage have been reported after exposure to high concentrations of xylene; however, after removal from exposure, recovery from these effects is usually rapid and complete.

Chronic: There do not seem to be significant health effects from exposure to low levels of xylene. A defatting dermatitis can occur after prolonged skin exposure. The hemopoietic injury associated with benzene does not occur with xylene.

MAXIMUM ALLOWABLE CONCENTRATION For occupational exposure - 100 parts of xylene per million parts of air.

PROTECTIVE MEASURES Xylene should be used in cool, well ventilated areas away from open flame. If welding is to be done on vessels which have contained xylene, it should first be ascertained that all xylene and xylene vapors have been evacuated to prevent fire and explosion.

If workers must enter a tank or enclosed space which contains or has contained xylene, they should be provided with and required to wear either a life line and supplied air respirator, or a self-contained oxygen breathing apparatus which have been approved by NIOSH. A co-worker should be stationed outside the tank for the purpose of emergency rescue. Protective clothing including gloves should be worn to avoid skin absorption.

Approved gas maks may be used for emergency purposes for short exposure periods. The proper gas mask canister is black or black with a gray stripe. Canisters should not be re-used. The service life of a canister is approximately 25 minutes. The canister should be replaced during use if (1) any leakage is detected by smell or irritation, (2) high breathing resistance develops, (3) a window indicator (when present) shows a specified color change, or (4) the shelf life is exceeded.

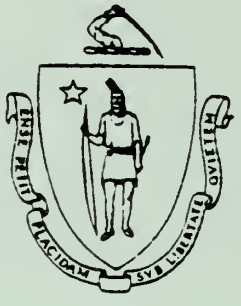
The concentration of xylene vapor can be determined by air analysis, and worker exposure can be estimated by urine analysis for methyl hippuric acid.

Since some commercial xylenes may contain significant amounts of BENZENE (see Chemical Data Sheet No. 3), an analysis of benzene concentration should be obtained for any commercial xylene, and if supplier or source changes, a new analysis should be made.

MEDICAL CONTROL If a worker shows symptoms of xylene overexposure, he should be removed from the hazardous area immediately and a physician should be summoned.

PREVENTION

DETECTION



EVALUATION

CONTROL

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October, 1981

INORGANIC ARSENIC

HAZARD CLASSIFICATION HIGHLY TOXIC BY INGESTION OR INHALATION

GENERAL Arsenic is a metal found abundantly in nature, often as an impurity of other metal ores. The most common form is the grey crystal or dust. Elemental arsenic is insoluble in water. It is dangerous when heated or on contact with acid or oxidizing agents. Arsenic trioxide is the principal form in which the element is utilized in industry. Arsenic trioxide is also produced as a by-product in primary smelting of metal ores, particularly copper.

Arsenic and its compounds are commonly used in pesticides, pigment production, manufacture of glasses and enamels, antifouling paints, and as hardening agents in metal alloys.

HARMFUL EFFECTS Acute Poisoning. Most cases of acute poisoning occur following ingestion. This is rare in industry. Acute arsenic poisoning following inhalation exposure can occur, although this is very unlikely. When it does happen, the symptoms which are experienced are cough, shortness of breath, giddiness, headache and extreme general weakness. Gastrointestinal symptoms develop after respiratory symptoms have appeared.

Chronic Poisoning. Following chronic inhalation exposure to arsenicals, symptoms usually progress through three phases: first, weakness, loss of appetite, nausea, and intermittent vomiting and diarrhea; second, eye inflammation, inflammation of the mucous membranes of the nose, throat and respiratory passages, with possible hoarseness, perforation of the nasal septum, keratotic skin lesions, scaling eczematous rash and, infrequently, skin cancer; and third, nervous system effects either in the form of peripheral neuropathy manifested by numbness of hands, feet and toes, with possible progression to paralysis in severe cases. Other effects from chronic inhalation exposure to arsenic and its inorganic compounds are: increased probability of lung cancer, depression of bone marrow and possible liver damage.

MAXIMUM ALLOWABLE CONCENTRATION For occupational exposure - 0.2 milligram arsenic per cubic meter of air. For arsenic trioxide (As_2O^3) 0.05 milligrams per cubic meter of air. This exposure does not apply to arsine or organic arsenicals.

PROTECTIVE MEASURES Protective clothing, including gloves, goggles and respirators, should be worn when handling arsenic and its compounds. Workers should be trained in personal hygiene, use of equipment, and early recognition of symptoms. Engineering controls shall be used to maintain arsenic concentrations at or below prescribed limits.

MEDICAL CONTROL Biological monitoring of employees handling arsenic compounds should be performed on a regular basis. Urine levels greater than 1.0 milligrams of arsenic per liter are indicative of an excessive exposure. Workers should be examined annually for evidence of arsenical keratoses, neurological disease and symptoms of arsenic poisoning. Screening for lung cancer does not appear to improve prognosis.

If an acute exposure occurs, take the victim to a clean area, remove contaminated clothing under a shower, flush exposed skin thoroughly with water, and call a physician. Acute arsenic poisoning may respond to early treatment with BAL.

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No. 1285 May, 1980

TETRACHLOROETHANE

HAZARD CLASSIFICATION HIGHLY TOXIC. *Use with caution.*

GENERAL Tetrachloroethane, one of the most toxic chlorinated hydrocarbons, is considered to be a very severe industrial hazard. It is a nonexplosive, nonflammable volatile yellowish liquid with an odor resembling that of chloroform. Tetrachloroethane is used in the chemical industry for the manufacture of other chlorine derivatives of carbon. It is also used as a solvent for oils, fats, waxes and soft resins. It is also employed in the manufacture of enamels, certain lacquers, nonflammable film, artificial pearls, gas masks, and for the cleaning of pictures and of inking rolls for lithographic plates.

HARMFUL EFFECTS Initial symptoms resulting from exposure to the vapor are lacrimation, salivation, irritation of the nose and throat and numbness of the toes and fingers. Continued exposure to high concentrations results in restlessness, dizziness, nausea, vomiting and narcosis. Patients' complaints gradually progress to serious illness, with development of jaundice, liver tenderness and possibly albuminuria and edema. When serious liver damage occurs, the jaundice becomes more pronounced, and toxic symptoms with somnolence, delirium, convulsions and coma appear, usually followed by death.

Tetrachloroethane has been shown to cause cancer in mice, but NIOSH has found no evidence of carcinogenic effect of chloroethanes in humans.

MAXIMUM ALLOWABLE CONCENTRATION For continued occupational exposure--5 parts of tetrachloroethane per million parts of air.

PROTECTIVE MEASURES Processes requiring the use of tetrachloroethane should be carried on in separate rooms provided for that purpose. A local exhaust system to remove tetrachloroethane vapor at its point of origin should be installed.

In the event of an accidental spill a canister gas mask with a canister filled with a suitable absorbent should be available.

MEDICAL CONTROL All persons should be given a physical examination before being allowed to work where tetrachloroethane is used. Persons with neurologic or liver disorders should not be allowed to work with this solvent. All persons employed in rooms where tetrachloroethane is used should be given periodic medical examinations which should include tests of liver function and a screening neurological examination. Upon the first display of symptoms of poisoning, the person affected should leave the workroom and obtain a medical evaluation.

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No. 1301 May, 1980

RECOMMENDED SAFE PRACTICES CHEMICAL DATA SHEET NO. 42

DIOXANE

HAZARD CLASSIFICATION Moderately toxic and flammable

GENERAL 1, 4-Dioxane is a colorless liquid with an ethereal odor. It is used as a solvent for lacquers, paints and varnishes; as a wetting agent in textile processing; in stain and printing compositions and in detergent preparations.

HARMFUL EFFECTS Common harmful effects from overexposure are eye irritation, burning sensation in the nose and mouth, vertigo and nausea. Kidney and liver failure may occur in excessively exposed persons. Dioxane is an animal carcinogen, but evidence of cancer induction in man has not been clearly determined.

MAXIMUM ALLOWABLE CONCENTRATION 25 parts dioxane per million parts of air for continued exposure

PROTECTIVE MEASURES The operation should be enclosed wherever possible and local exhaust ventilation be provided to assure that the working area will be well ventilated. Air analyses should be performed to determine the concentrations in the working atmosphere.

Skin contact should be avoided. If this is not possible, the skin should be protected by gloves or barrier creams.

Persons unavoidably exposed to hazardous amounts of dioxane should wear full facepiece airline respirators approved by the U. S. Department of Health, Education and Welfare, National Institute for Occupational Safety and Health (NIOSH).

MEDICAL CONTROL Any worker who has dioxane contact with theeyes or skin should wash the area with water promptly. Accidental ingestion should

be treated by drinking salt water and inducing vomiting. In case of unconsciousness, artificial respiration should be administered while awaiting the arrival of a summoned physician. Periodic medical examinations for exposed workers should include history, physical ~~exam~~ examination, kidney and liver function tests and a urinalysis.

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No. 1303 May, 1980

ETHYLENE OXIDE

HAZARD CLASSIFICATION EXTREMELY TOXIC AND HIGHLY FLAMMABLE - Use with Extreme Caution

GENERAL Ethylene Oxide (CAS #75-21-8), also known as 1,2-epoxyethane, oxirane, or dimethylene oxide (abbreviated as EtO or EO). It is a colorless gas with an ether-like odor. It is manufactured through the oxidation of ethylene in the presence of a silver catalyst. It is one of the twenty-five most produced chemicals, by volume, in the U.S. The major use of ethylene oxide (EtO) is in the manufacturing of ethylene glycol, usually under closed conditions because of its hazardous properties. It is also used as a sterilant or fumigant, which is where the most significant human exposure is found due to inadequate engineering controls and work practices. More than 8,000 hospitals nationwide use ethylene oxide sterilization units with roughly 100,000 hospital workers potentially exposed.

PHYSICAL PROPERTIES Ethylene oxide (EtO) is an extremely flammable gas at room temperature. Lower and upper explosive limits are 3% and 100% by volume of air, respectively. Ethylene oxide may be recognized by its sweet odor and irritant effects, but the odor is inadequate to serve as a warning of dangerous concentrations. The odor threshold for most people is between 300 and 1500 ppm (parts per million), but olfactory fatigue occurs with continued exposure.

HARMFUL EFFECTS Acute: Accidental exposure to high concentrations of ethylene oxide (EtO) has been reported to cause irritation of the eyes, nose, and throat, headaches, nausea, vomiting, drowsiness, incoordination, shortness of breath, pulmonary edema (which may occur hours after exposure), elevation of the lymphocyte count, and death. The airborne concentrations during such episodes has generally not been known. It can be expected, based on animal studies, that the concentration required to produce acute effects will depend on the duration of exposure. Acute effects might occur from an 8 hour shift of 100 to 200 ppm, or in minutes from exposure over 1000 ppm.

Liquid ethylene oxide (must be below 10.7C or 51.3 F to be in liquid form) or aqueous solutions of ethylene oxide can cause severe skin burns or eye injury from direct contact. Ethylene oxide (EtO) residue in sterilized dressings can cause skin irritation. Allergic sensitization of the skin has also been reported.

Chronic: Peripheral neuropathy has been reported in workers exposed intermittently to levels of ethylene oxide (EtO) in excess of the odor threshold over a period from two weeks to two months.

Ethylene oxide has been shown to produce cell mutations, birth defects, and malignancies in laboratory animals. Limited human data suggests that EtO (ethylene oxide) exposure may increase the risk of certain malignancies (such as leukemia) and may cause adverse reproductive effects. An increase in chromosomal abnormalities in lymphocytes of exposed workers (which is of unknown health significance) has been reported to occur at exposures well below those needed to produce acute symptoms.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure--1 part of ethylene oxide (EtO) per million parts of air.

PROTECTIVE MEASURES

1. Engineering Controls: General ventilation and/or local exhaust must be installed in the workplace to reduce and maintain employee exposure below the maximum allowable concentration, except to the extent that such controls are not feasible.

2. Respiratory Protection: The employer shall provide respirators and ensure that they are used whenever required. This includes situations where engineering controls are not feasible, insufficient or in the process of being installed. Emergency situations are also included. All respirators must be jointly approved as being acceptable for protection against ethylene oxide by MSHA (Mine Safety and Health Administration) and NIOSH (National Institute for Occupational Safety and Health). Whenever respirator use is required, OSHA mandates that the employer institute a respirator program (see 29 Code of Federal Regulations 1910.134)

The following table gives the minimum requirements for respiratory protection:

Air Concentration of Ethylene Oxide (EtO) (ppm)	Minimum Required Respirator
less than or equal to 50	Full facepiece respirator with EtO approved canister (by MSHA and NIOSH, see above)
less than or equal to 2000	Positive-pressure supplied air respirator, equipped with full face-piece, hood or helmet or Continuous-flow supplied air respirator (positive pressure) equipped with hood, helmet or suit
greater than 2000	Positive-pressure self-contained breathing apparatus (SCBA) equipped with full facepiece or Positive-pressure full facepiece supplied supplied air respirator equipped with an auxiliary positive-pressure self-contained breathing apparatus

Note: Respirators approved for use in higher concentrations are permitted to be used in lower concentrations

3. Protective Clothing: The employer should provide, at no cost to the employee, appropriate protective clothing where skin contact to liquid ethylene oxide or EtO solutions may occur. This may include impermeable clothing, gloves and a face shield.

4. Eye Protection: The employer must provide appropriate eye protection, at no cost to the employee, where eye contact to liquid EtO or EtO solutions may occur. This would consist of splashproof safety goggles. Contact lenses should not be worn.

5. Warning Signs and Labels: OSHA requires that the employer post and maintain legible signs with the following information:

DANGER
Ethylene Oxide
Cancer Hazard and Reproductive Hazard
Authorized Personnel Only
Respirators and Protective Clothing
May Be Required to Be Worn In This Area

Containers of EtO must have the label:

CAUTION
Contains Ethylene Oxide
Cancer and Reproductive Hazard

The label must also have a warning against breathing in ethylene oxide.

6. Training: The employer is required (under OSHA and the Massachusetts Right to Know Law) to provide information and training to all employees who are potentially exposed to EtO. The training should occur when an employee is hired and annually thereafter.

7. Precautions for Safe Use, Handling and Storage: EtO is a flammable liquid and its vapors can easily form explosive mixtures in air. It is important therefore to store EtO in tightly closed containers, in cool, well-ventilated areas, away from heat, sparks, flames, strong alkalines, acids, and bases.

8. Other Controls:
   (a) Fire extinguishers, emergency deluge showers, and eye wash stations should be readily available.
   (b) Hand valves must be installed on the gas supply at the connection to the supply cylinders to minimize leakage during a change of cylinders.
   (c) An audible and visual alarm system must be installed to alert personnel of ventilation system failures.

9. Sterilizer Units: Sterilizer systems should be checked for leaks every two weeks. For those sterilizers using an 88% freon (chloro-fluorocarbon), 12% EtO mixture, exposure to the freon is another potential health hazard (e.g. heart sensitizer). For more information on the use of EtO sterilizers see OSHA Standard, 29 CFR Part 1910, Appendix A

MEDICAL SURVEILLANCE Due to the delayed health effects associated with exposure to ethylene oxide, medical monitoring can only serve as a supplement to environmental monitoring. Only environmental monitoring can detect excessive exposure so that corrective measures can be taken.

OSHA requires (section 1910.1046) that medical surveillance be offered to all workers who might be exposed to or above the action level of 0.5 parts per million of ethylene oxide. Medical examinations should be carried out before a worker begins work in a job with potential exposure, annually while exposure might occur, and upon leaving a job with potential exposure. The examinations should include a medical and occupational history and a physical exam with special attention to the pulmonary (lung), hematologic (blood), eyes, skin, neurologic (nervous) and reproductive systems. A complete blood count (including a differential white cell count) should be included. Employees should be informed of the results of their medical surveillance examination.

EMERGENCY FIRST AID

Inhalation: There is no specific antidote for EtO poisoning, but emergency medical evaluation and supportive treatment is necessary in all cases of accidental exposure to high concentrations of EtO. Any worker accidentally exposed to high concentrations of EtO should be removed from exposure immediately. Because some effects of acute overexposure can be delayed, workers so exposed should be evaluated by a physician as soon as possible, even if they do not have symptoms at the time of the accident. In cases where cardiopulmonary resuscitation (CPR) is needed, it should be administered immediately after the victim is removed from the exposure.

Skin contact: Contaminated skin should be washed immediately with water and contaminated clothing should be removed. Medical attention is necessary for skin burns from EtO. The contaminated clothing should be washed down thoroughly before reuse and only impermeable clothing should be used. Once EtO penetrates shoes or other leather articles, they should not be worn again.

Eye Exposure: The eyes should immediately be washed thoroughly with water, lifting the upper and lower eyelids. The exposed worker should receive immediate medical attention.

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No. 1376 March, 1986

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ANTHRAX

(MALIGNANT PUSTULE, WOOLSORTER'S DISEASE, RAG PICKER'S DISEASE)

HAZARD CLASSIFICATION A SERIOUS, SOMETIMES FATAL, INFECTIOUS DISEASE

GENERAL Anthrax is a disease of certain animals, widespread in countries with poor public health protection. It is caused by the anthrax bacillus. The bacillus forms spores which survive even under extreme conditions of temperature or dryness throughout many years and are therefore responsible for new infections when conditions favorable for bacterial growth are present.

While anthrax is primarily a disease of animals, it may be transmitted to men, particularly those engaged in handling infected animals and animal products. The organism enters the human body through any of three routes: skin, respiratory passages or gastrointestinal tract. The skin is the most frequent site of infection from occupational exposure.

Although the disease in animals is well controlled through vaccination in most parts of the U. S. A., isolated human cases caused by imported infected materials are still observed every year. These occur among sorters of hides and wool; tanners and other leather workers; brush and bristle makers; workers who handle felt or hair, particularly goat hair, and hair products; those who handle animal bones or bone products; those who handle insulation material; and those involved in the shipment of infected materials, such as truckers and longshoremen. Veterinarians and agricultural workers handling infected animals are also at risk.

Most cases of anthrax in the U. S. are sporadic, although epidemics occasionally occur.

Three types of anthrax occur--cutaneous, inhalation and gastrointestinal, determined by the mode of entry of the infectious agent and the area affected. Cutaneous and inhalation anthrax can result from occupational exposure and are described below.

Cutaneous Anthrax: A slight skin injury on an exposed area, such as the hands, arms, neck or face, in the presence of infected materials may lead to anthrax infection. The first manifestation of cutaneous anthrax is usually a small pimple, which is usually painless but itchy. In a few days this enlarges and becomes surrounded by blebs or blisters. A thick crust then forms with dead tissue beneath, and the lesion becomes painful. The surrounding skin will then become edematous (swollen), and infected individuals usually feel generally ill, feverish and sometimes nauseated if the illness progresses to this point. Untreated infections can spread to lymph nodes in the infected area and then to the bloodstream, producing a serious systemic illness. Treatment with appropriate antibiotics is generally curative of cutaneous anthrax if begun early enough.

Inhalation Anthrax: This rare but severe form of anthrax occurs when airborne infected material is inhaled. It usually begins as a febrile upper respiratory illness. Infection of the mediastinum (tissues between the lungs) follows as part of a rapidly progressive and often fatal illness manifested by fever, respiratory distress and shock.

Gastrointestinal Anthrax: This exceedingly rare form of anthrax is extremely rare in the U. S. A. and is generally not an occupational disease. It is caused by the ingestion of infected meat.

PROTECTIVE MEASURES

1. In the U. S. contact with imported animal skins, hair or wool from less developed countries is an important source of infection. Disinfection or sterilization of anthrax-suspect materials prior to processing should be employed. Formaldehyde has been effective in eliminating the anthrax-causing bacteria from infected materials. Other measures, such as steam, have been less effective.

2. Engineering measures should be employed to minimize exposure to dust where potentially infected material is processed.

3. Protective gloves, aprons and boots should be worn by employees to prevent skin contact with suspect materials. Any skin abrasions should receive careful medical attention and protection from exposure. Suspect skin lesions should be brought to medical attention quickly.

4. Personal hygiene practices should include thorough hands washing for employees prior to eating and showering with soap and water and changing of clothing at the end of a work shift. Work clothes should be laundered at frequent intervals. The employer should provide necessary facilities and education to facilitate such practices.

5. Immunization of persons at high risk for exposure to anthrax, including veterinarians and those handling potentially contaminated materials in industry, is recommended. For information regarding the vaccine, direct inquiry to U. S. Center for Disease Control, Atlanta, Georgia 30333, or the Michigan State Health Department, P. O. Box 30035, Lansing, Michigan 48909.

6. Cases of anthrax should be reported to local public health authorities.

7. Drainage from skin lesions of cases of cutaneous anthrax should be regarded as infectious, although no cases of person to person transmission have been reported.

Where anthrax is a hazard this Department's Industrial Bulletin No. 6, entitled, "Rules and Regulations for the Prevention of Anthrax," should be referred to for the official regulations of the Department of Labor and Industries.

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No. 1371 Supersedes No. 1156 November, 1985

BRUCELLOSIS (UNDULANT FEVER)

HAZARD CLASSIFICATION AN ACUTE OR CHRONIC DEBILITATING DISEASE.

ETIOLOGY Brucellosis or undulant fever is caused by a bacterial organism known as Brucella abortus. Brucella melitensis, or Brucella suis bacillus.

GENERAL It is primarily a disease of cattle, swine, sheep and goats and is transmitted to individuals handling infected animals or carcasses or through ingestion of unpasteurized milk or milk products. Farmers, dairymen, stockmen, butchers, veterinarians, as well as slaughter-house and packinghouse workers, are exposed to this disease. Provided the physician is aware of the possibility of this disease, the diagnosis may be made through blood cultures or paired serologic tests, although sometimes examination of the bone marrow or other tissues is necessary.

ONSET AND COURSE OF ILLNESS The organism enters the body through the gastrointestinal tract or, less frequently, through the skin or mucous membranes. Following an incubation period varying from one to four weeks, the infected individual notices weakness, headache, fatigability, muscle and joint pain, chills and fever. This period will last for several weeks or even months. After the acute episode, there frequently follows a period of recurrent attacks of fever, accompanied by weakness, rheumatic pain, abdominal distress, which may incapacitate the worker for a considerable length of time.

PREVENTIVE MEASURES Strict veterinary supervision, with elimination of infected animals and vaccination of exposed livestock, has all but eradicated the disease in Massachusetts, as well as in many other states of the U.S.A. However, in some states undulant fever still occurs to a greater extent. The use of pasteurized milk will remove one of the main sources of human infection.

Individual cleanliness is of great importance. Workers in exposed occupations, such as farmers, livestock handlers and veterinarians, should wash thoroughly with warm water and soap before meals and at the completion of the day's work.

Those who come in contact with parts or products of infected animals should wear gloves and refrain from eating inadequately processed meat or drinking unpasteurized milk.

MEDICAL CONTROL Individuals handling contaminated carcasses, meat, or unpasteurized milk products should immediately report to a physician any unexplained illness, particularly if associated with fever, in order to permit early diagnosis and correct treatment with an antibiotic.

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LEPTOSPIROSIS (WEIL'S DISEASE)

HAZARD CLASSIFICATION A SEVERE INFECTIOUS DISEASE

GENERAL Leptospirosis occurs as an occupational disease among coal miners, sewer workers, fish cutters, butchers, and laboratory workers. The Leptospirae bacteria which cause this disease are transmitted to man by contact with infected animals, such as dogs, swine and rats, or by their excreta (urine, stool). The causative agent survives in damp or humid environments, such as mines, sewers, and waterfront areas. The infection is acquired by such portals of entry as the injured skin or the gastro-intestinal tract through ingestion.

ONSET After an incubation period lasting from several days to several weeks, the infected individual experiences chills, high fever, headache, muscle cramps, particularly of the legs, prostration, and abdominal pain with nausea and vomiting. Jaundice is present in about 50 percent of the cases. Inflammation of the eyes frequently occurs and may be followed by jaundice with bleeding tendencies which may last for several weeks. The disease is severe, and eight to 30 percent of the cases are fatal. The diagnosis is established by demonstration of the organism in the urine and/or blood. Serological tests indicate recent infection.

MEDICAL CONTROL Since this disease is primarily one of animals, particularly rats, preventive control is by an effective rat extermination program. The use of protective clothing, boots and gloves to minimize skin contact with potentially infected material should be encouraged. An individual who comes in contact with material infected by rats in the course of his work should report any of the symptoms mentioned above to a physician, since early diagnosis of this disease will permit treatment with antibiotics and shorten the course of the disease.

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ERYSIPELOID

HAZARD CLASSIFICATION A local skin disease of varying severity.

GENERAL Erysipeloid is a mild localized skin infection that occurs at a point of injury which is usually the hand. The infection is due to the Erysipelothrix bacillus. Infection in humans is virtually restricted to persons who handle dead animal matter, be it edible (meat, poultry, fish, shellfish) or nonedible (bones, shells). It is a common occupational disease among abattoir workers, fish handlers and retail butchers. At risk are not only those directly associated with slaughtering swine but also anyone who handles pork, pork products, bones or meat refuse. The causative organism may also be present in boxes, crates, tables and door handles that have been indirectly soiled with swine or fish material. There are no vectors, and the infection is not contagious. Any cut or minor skin break may provide an avenue for the infection. Twenty-four to 48 hours later, the worker is aware of a painful throbbing, followed by a purplish-red swelling, with a sharply-defined, irregular, raised border at the point of skin injury. Particularly with lesions of the fingers, the swelling may be sufficient to limit movement of nearby joints. The lesions itch and burn, but usually there are no swollen glands or symptoms of systemic disease.

MEDICAL CONTROL The application of common-sense hygienic methods is of paramount importance. Workers should be encouraged to wash their hands frequently and thoroughly with copious amounts of soap and hot water. The prompt first-aid treatment of all minor skin injuries should be carried out. It is to be emphasized that the organism causing the disease may invade the body through the most trivial skin break--consequently the necessity for prompt care of minor wounds. Any infection of the fingers or hand accompanied by purplish-red discoloration and joint pain should be seen by a physician and the possibility of erysipeloid considered. Workers who handle swine and fish products should be educated as to the need for giving a detailed occupational history to their physician. Antibiotic medication, such as penicillin or tetracycline, is highly effective.

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RECOMMENDED SAFE PRACTICES **MEDICAL DATA SHEET NO. 5**

ORNITHOSIS

(PSITTACOSIS, PARROT FEVER)

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HAZARD CLASSIFICATION A SERIOUS RESPIRATORY DISEASE

GENERAL Ornithosis is an infection acquired through contact with all sorts of diseased birds. It is prevalent among South American parrots and parakeets. The infection may be spread to pigeons, canaries and other domestic birds through contact with imported birds. Ornithosis is an occupational disease of persons associated with pet shops, aviaries, pigeon lofts, poultry farms, poultry processing and rendering plants. Persons culturing the organism in laboratories are at particular risk. Nurses and other hospital personnel may be infected by acutely ill patients.

Manifestations of the disease in birds may be subtle, but diseased birds usually show lack of appetite, disheveled appearance of feathers, diarrhea or convulsions. The infectious agent may be present in the blood, feathers, excreta and discharges of diseased birds.

In humans, after an incubation period of seven to 14 days, severe cases become manifest as an upper respiratory illness accompanied by high fever, a dry cough, back pain, headache, nausea, vomiting and diarrhea. Rapid progression to pneumonia follows. Less severe cases can resemble a mild influenza-like illness and frequently go undiagnosed. The organism can be isolated in laboratory animals or tissue cultures, but suspected cases are more often confirmed through blood tests showing an increase in antibodies to the causal agent. Early recognition of cases is important so that treatment with appropriate antibiotics can be initiated promptly.

PREVENTIVE MEASURES Ornithosis occurs only through exposure to infected materials, birds or humans. The likelihood of such exposure should be minimized as follows:

1. Imported birds are often a source of the infection, and in the United States imported birds are treated prophylactically and quarantined at the port of entry before distribution. Still, those handling imported birds should consult a veterinarian if an imported bird shows signs of ornithosis as described above.

2. Illness or unexplained death of birds in captivity should raise suspicion of ornithosis. Consultation with a veterinarian for prompt diagnosis will allow for treatment of exposed birds to prevent spread of the illness. Where ornithosis is suspected, dead birds should be submitted for post-mortem examination, following instructions of the veterinarian or laboratory for disinfecting and packaging the carcass for shipping. Diseased birds generally are destroyed and the area where they were housed thoroughly disinfected. Quarantine of farms or premises housing pet birds is indicated until the infection has been eradicated.

3. Ventilation, isolation and personal protective equipment should be used to minimize the possibility of inhalation of potentially infected materials. These precautions are indicated in settings where discharges, blood or feces from infected birds might be present or in laboratories where the organism causing ornithosis is being isolated in animals or tissue cultures.

4. The disease should be suspected in any flu-like illness or pneumonia in workers at risk of exposure (see above). Any diagnosed case should be reported to public health authorities so that investigation of the possible source of infection can be carried out.

5. Respiratory secretions from suspected human cases should be regarded as infectious and appropriate precautions taken. Patients with the illness should be instructed to cough into tissues to prevent airborne transmission of the organism.

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GAS GANGRENE

HAZARD CLASSIFICATION *A SERIOUS, OFTEN FATAL DISEASE UNLESS TREATED PROMPTLY.*

ETIOLOGY Gas gangrene is caused by a group of anaerobic bacilli known as Clostridia.

GENERAL The gas gangrene bacilli are normally present in the soil, often together with the tetanus bacillus. They exhibit a characteristic tendency to grow in the absence of oxygen and in devitalized tissues, with the formation of gas bubbles. If they enter deep tissues, such as in crushing or penetrating injuries, they will multiply rapidly.

ONSET AND COURSE OF ILLNESS Infection with gas gangrene is preceded by a short incubation time, usually from one to four days. The first signs of the disease are fever with swelling and stiffness of the affected muscles, accompanied by severe pain. Soon edema sets in, with formation of gas, which can be felt as crepitation and seen on X-ray films. The affected tissues turn brownish and lose their normal appearance. The patient, unless treated early, becomes progressively weaker and will frequently succumb within a few days.

MEDICAL CONTROL Gas gangrene can be prevented if expert surgery and strict asepsis are carried out immediately after severe injuries. In suspected cases and particularly during wartime, a gas gangrene antitoxin should be given. Once the infection has set in, high doses of penicillin must be administered, and under certain conditions affected extremities must be amputated in order to save the patient's life. At medical centers having hyperbaric chambers this method of high oxygenization has been tried successfully.

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TETANUS "LOCKJAW"

HAZARD CLASSIFICATION A DISEASE FREQUENTLY FATAL IF NOT TREATED EARLY AND INTENSIVELY.

GENERAL Tetanus is caused by the tetanus bacillus which grows in the absence of oxygen. This bacillus occurs as a resistant spore which can develop rapidly and is present everywhere. When tetanus bacilli enter the body through injuries, they increase rapidly in those tissues which are not in contact with air. Thus accidents which leave the skin fairly intact, such as penetration of a nail, the lodging of deep splinters, bullet wounds, and crash injuries, are more likely to cause tetanus than cuts leading to wide open wounds. As tetanus bacilli grow, they form a poison (toxin) which enters the bloodstream, and after a delay of several days reaches the nervous system. Thus tetanus shows the first clinical signs after a latent (incubation) period. This permits treatment at the time of an injury to prevent the nervous system effects (lockjaw). The length of the incubation period varies from one to 21 days. Individuals who are partially immunized may show a much longer incubation time.

CLINICAL COURSE The first clinical signs appear as a feeling of stiffness in the arms or legs, pain on opening the mouth and chewing, or pain and stiffness in the neck, with a tendency to become worse upon stimulation, such as touch, light and motion. Within a few hours, stiffness and pain increase in severity. During the interval between spasms, the patient feels feverish and weak. If untreated, his condition progresses to a state of almost continuous spasm, with lockjaw, a tendency to convulsions, and severe respiratory distress. Many will die either from respiratory failure or pneumonia; those who have milder cases may recover.

Once tetanus is clinically recognizable, the patient requires hospitalization for treatment with a combination of serum therapy, antibiotics, and measures to combat the spasm and respiratory distress.

PREVENTIVE MEASURES The tetanus bacillus, particularly its heat-resistant spores, tends to survive in a favorable environment for many years. Thus wounds contaminated with soil, dust, or dirt are always endangered and require particular medical attention. Any puncture wound should be examined by a physician.

MEDICAL CONTROL 1. Experience has shown that a program of active immunization in the form of tetanus toxoid inoculations, followed by booster doses, greatly diminishes the incidence of tetanus. All industries should employ a similar program of active immunization and regular boosters every 10 years.

2. In those previously immunized immediate administration of tetanus toxoid booster must be given in case of any injury where tetanus infection is considered at all possible.

3. Physicians must carefully clean any contaminated wound and widen it if necessary to permit better access to oxygen.

4. The following table is a conservative guide to active and passive tetanus immunization at the time of wound cleaning or debridement. It presumes a reliable knowledge of the patient's immunization history.

GUIDE TO TETANUS PROPHYLAXIS IN WOUND MANAGEMENT

History of Tetanus Immunization (Doses)	Clean, Minor Wounds		All Other Wounds	
	Td	TIG	Td	TIG
Uncertain	Yes	No	Yes	Yes
0 - 1	Yes	No	Yes	Yes
2	Yes	No	Yes	No[1]
3 or more	No[2]	No	No[3]	No

1. Unless wound more than 24 hours old.
2. Unless more than 10 years since last dose.
3. Unless more than 5 years since last dose.

Td = Tetanus and Diphtheria toxoids, adult type.

TIG = Tetanus Immune Globulin (Human)

If passive immunization is to be used, TIG is preferable to animal antitoxin. It offers the advantages of longer protection and freedom from undesirable reactions. The currently recommended prophylactic dose of TIG is 250 units for wounds of average severity. When tetanus toxoid and globulin are given concurrently, separate syringes and separate sites should be used.

Should TIG be unavailable, equine or bovine antitoxin may be used, but there is a risk that serious anaphylactic or serum sickness reactions will follow. Its administration should always be preceded by careful screening for sensitivity in accordance with instruction accompanying the antitoxin. The usual dose is 3,000 to 5,000 units.

TETANUS IS A PREVENTABLE DISEASE Every contaminated injury, even if seemingly insignificant, must be reported to the proper authority as soon as possible. If tetanus is at all possible, a booster should be given.

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POISON IVY DERMATITIS

Poison ivy dermatitis is a skin eruption which occurs as a result of contact with an irritant substance contained in plants of the species rhus toxicodendron. While other plants, such as poison oak and poison sumac, will cause a similar eruption, poison ivy dermatitis is the one most commonly encountered in the U.S.A. Since preventive measures, appearance of the skin lesions and treatment apply equally to poison ivy, poison oak and poison sumac, the following discussion applies to all these forms of skin irritation.

CAUSE Poison ivy dermatitis is caused by direct contact with a nonvolatile phenol known as urushiol, which is present in the sap of the plant. Even minute quantities of this substance will lead to skin inflammation and allergy in susceptible individuals. Burning of leaves may transport the poison to the skin, while contaminated clothing and domestic animals may act as intermediary sources of the disorder. However, in contrast to common belief, the fluid contained in the blisters which form in the course of poison ivy dermatitis does not contain the poison.

Unless removed from the site of contact, small amounts of the irritant are apt to be carried from the original site to other areas of the body. Similarly, ointments or other medication applied locally when the phenol is still present may spread the toxic substances from one place to another.

CLINICAL APPEARANCE The clinical signs and symptoms of poison ivy dermatitis vary according to the degree of susceptibility of the affected individual. The first contact with the plant in an unsensitized individual may cause painful blisters and confluent areas of a crusty skin inflammation which will remain up to five days without essential change in extent or appearance. If sensitization takes place and in case of repeated contact in individuals who are sensitive, there will be evidence of an allergic response, with spreading of the skin lesions, swelling of skin and subcutaneous tissues, and severe itching. This state usually lasts three to five days and is followed by slow drying up and healing of the crusted and blistered skin over a period of several weeks.

PREVENTION The most effective ways to prevent poison ivy dermatitis are as follows:

1. **Plant eradication.** The removal of all poisonous plants from places open to possible contact is highly desirable. Governmental agricultural stations have worked out procedures suitable for killing the weeds. Nevertheless, we have to accept the fact that poison ivy is probably here to stay.

2. **Recognition.** The old saying, "Leaflets three, let it be," as stressed by the U.S. Department of Agriculture (Farmers' Bulletin No. 1972) is the one consistent characteristic of the plant. The plant flowers with whitish blooms, which are followed by waxy white berries. It grows in the form of low shrubs, as well as climbing vines and therefore may resemble ornamental shrubs bordering houses or fences.

3. **Preventive creams.** Various preventive creams have been recommended and are used by individuals or groups upon medical advice. Most of these preparations contain sodium perborate or zirconium in a vanishing cream base.

4. **Desensitization.** In view of the sensitizing feature of the disease, many attempts have been made to desensitize susceptible individuals against allergic manifestations. Unfortunately, none of these methods has proven highly effective. The injection of poison ivy extract once widely used has been replacd recently by oral desensitization, which requires daily medication over long periods of time and has been known to cause side-effects, such as gastrointestinal upsets and rectal itching, without providing complete protection.

TREATMENT Once poison ivy dermatitis has developed, medication may be required for skin lesions and/or allergic manifestations.

1. **Skin lesions** occur in the form of blisters, crusts and inflammation. Before treatment of skin lesions is undertaken, it is essential that all traces of the irritating phenol be removed. This is best done by scrubbing the affected area with soap and water, followed by painting it with dilute alcohol or washing with a 1:1000 aqueous solution of potassium permanganate.

Skin irritation is relieved by application of fast-drying lotions or sprays which contain a mild anesthetic with the addition of a corticosteroid if itching or pain are particularly distressing.

2. Allergic manifestations are characterized by swelling of face or extremities (edema) and severe itching (urticaria). If an allergic reaction occurs, the use of an antihistamine or a corticosteroid by mouth or ACTH by inject on may be required.

In this second stage one may obtain relief for skin irritation and itching by applying locally calamine lotion or ointments which contain zirconium or a corticosteroid.

Poison ivy dermatitis will clear up by itself. Overtreatment, therefore, should be avoided. If the individual exposed to poison ivy is fully indoctrinated with the preventive methods outlined above, he should be safe from dermatitis. Once contact has been made, immediate removal of the poison from the skin and clothes will prevent further spread and thus avoid the possibility of an allergic reaction. Only a few individuals who are known to be highly allergic to poison ivy will require a program of desensitization either by mouth or injection under close medical supervision.

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CUTTING OIL DERMATITIS

DESCRIPTION A skin eruption which may occur on the forearms, thighs, hands, trunk or face of employees who operate machine tools or otherwise come in contact with cutting oils.

Generally it appears as a "pimply like" eruption involving the oil glands. These skin openings become blocked with oil and the accumulated secretions of the glands underneath and so appear as "blackheads" or pustules. There may be further irritation of the surrounding skin, thus producing redness and soreness. If the condition is allowed to continue or becomes aggravated either by home or work exposure, boils or other secondary infections may develop.

CAUSES Many factors are involved, and consideration should be given to the relative importance of each of the following:

1. Presence of irritating substances in the cutting oil. These may be metallic particles, chemicals or solvents.

2. Skin ailments of the worker prior to contact with cutting oils, e.g., acne, oily dandruff or excessively oily skin, and possibly allergic eczema.

3. Lack of access to lavatory facilities to maintain personal skin hygiene.

4. Lack of personal skin hygiene.

PREVENTION 1. Prospective employees should be free from allergy and past history of cutting-oil dermatitis.

2. Ample washing and showering facilities should be provided at the place of work.

3. Adequate supplies of a mild soap, or skin cleansers, should be provided and the employees instructed as to the necessity of thorough cleaning and rinsing of all skin areas which are exposed to the cutting oils and given sufficient time to do so.

4. When indicated, protective creams for hands and forearms should be provided. These creams are designed to be applied and rubbed in before any exposure to cutting oils occurs.

5. An ample supply of clean rags or cotton waste should be provided daily.

6. Foremen or supervisors should be made responsible for strict enforcement of company policy regarding skin hygiene before, during and at the end of the working day.

7. Cleanliness of underwear and frequent change of street and work clothes should be made mandatory. Whenever possible, management should supply work clothes and arrange for them to be cleaned.

8. When indicated, the cutting oil should be centrifuged and treated as it becomes contaminated with foreign bodies or chemicals. If employees still develop dermatitis, changing the kind of oil used may be helpful.

9. When the process causes splashing or spray, splash guards should be provided. All machines and work areas should be cleaned with a high flash naphtha type solvent.

10. If in some workers dermatitis persists after all control measures have been carried out, a permanent transfer to work stations free of cutting oil may be necessary.

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PERSONAL HYGIENE IN HANDLING EPOXY RESINS

Uncured epoxy resins should not come in contact with the skin at any time. The following rules should therefore be strictly observed:

(1) Before rubber gloves are put on, the hands should be thoroughly lubricated with the protective cream provided.

(2) Gloves must be worn on all wet operations. They should be attached to the work clothes in such a way that all bare areas of the arms are protected. Plastic cuffs may be utilized. Polyethylene aprons should be worn over the work clothes.

After Work

(1) The work area should be cleared of all contamination, and gloves should be thoroughly cleansed with warm water and mild soap before they are removed.

(2) A cleansing cream should be applied to the skin, followed by thorough washing with soap and water. Then a protective cream should be applied. Fingernails should be clean and kept short.

(3) Before leaving the plant, the employee should remove his work clothes, take a shower, and change into uncontaminated clothing. Any contact of bare skin, including the face, with soiled surfaces of gloves or sleeves through eating or smoking, particularly by wiping off sweat, must be avoided.

Skin irritation, such as dryness, itching, blistering or "weeping", should be reported immediately. Early recognition and treatment of such conditions may prevent progressive difficulties and loss of work time.

Note: Reference should be made to bulletin entitled, "Epoxy Resins", Chemical Data Sheet No. 34.

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SILICA

HAZARD CLASSIFICATION DUST - VERY HARMFUL - MAY CAUSE SILICOSIS.

GENERAL There are three crystalline forms of silica--quartz, tridymite and cristobalite--and several amorphous forms--opal and diatomaceous earth. Tridymite and cristobalite are considered to be more toxic than quartz, while the amorphous forms are not thought to cause pneumoconiosis.

Silica (silicon dioxide, "free silica") is a common ingredient in rocks and minerals. Only silica (SiO_2) is associated with silicosis, and this material should be distinguished from silicates (silicon combined with oxygen and another element, "combined silica"). Silicates such as asbestos and talc are the subjects of other bulletins in this series.

Silica occurs widely in sand, sandstone, granite and other rocks and is used or encountered in abrasives; sandblasting; chipping and buffing of metals; foundry core making and molding; precision casting; metallurgic processes; glass making; enameling; mining of hard rock (hard coal, copper, zinc, gold and silver); quarrying of granite, sandstone, quartz and crystal; stone and slate finishing; tunneling; and brick making.

HARMFUL EFFECTS Silicosis is a disease of the lungs caused by inhalation of silica dust. The period between first exposure and onset of disease depends on the amount of dust exposure and may vary from six months to 30 years. The early effects of silicosis may appear only on chest X-rays or in pulmonary function tests without clinical symptoms. Removal from exposure at this time is probably associated with no further disease progression. Continued exposure results in the onset of symptoms of chronic respiratory disease, such as shortness of breath and cough. The symptoms progress to include severe shortness of breath, difficulty in breathing, weight loss and decrease in energy and ultimately results in complete disability. Persons with silicosis are more susceptible to infection with tuberculosis.

MAXIMUM ALLOWABLE CONCENTRATION 100 micrograms of free silica per cubic meter of air. Since it is only the respirable particles of silica, especially those less than 5 micrometers (microns) in diameter, which cause silicosis, the maximum allowable concentration is based on the amount of these respirable particles in the air rather than in the total free silica concentration. If the respirable dust contains contaminants in addition to free silica, then the MAC of the mixture can be calculated as follows:

Mass. Respirable Method (mg. per M^3) $\dfrac{10}{\text{Per cent Respirable Quartz} + 2}$

Light Field Dust Counting Method (MPPCF) $\dfrac{300}{\text{Per cent Respirable Quartz} + 10}$

Note: For cristobalite and tridymite, use one half the value calculated from the count or mass formula.

For fused silica and tripoli, use the above formulas.

PROTECTIVE MEASURES If the silica-containing material cannot be replaced by a less harmful substance, then the dust should be controlled at the point of origin by the use of local exhaust systems or wet methods. The operation dispersing the dust should be isolated or enclosed or the operation so changed as to eliminate the dispersion of the dust. NIOSH-approved dust type respirators, air-line respirators or helmets are recommended only as a last resort and usually for short periods of time. A combination of one or more of the above methods may be employed.

MEDICAL CONTROL Pre-employment physical examination, including a full plate (14 in. x 17 in.) X-ray of the chest and ventilatory function tests($FEV_{1.0}$ and FVC) should be required of all employees where exposure to excessive silica-containing dust will be encountered.

Individuals with evidence of pulmonary disease should not be exposed to silica dust. Periodic examinations, including chest X-ray and ventilatory function tests, should be required of all persons employed in dusty operations. It is recommended that the chest X-ray and ventilatory function tests be performed on alternating years so as to avoid unnecessary radiation exposure.

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ASBESTOS

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HAZARD CLASSIFICATION DUST VERY HARMFUL - MAY CAUSE ASBESTOSIS, LUNG CANCER, OR MESOTHELIOMA.

GENERAL Asbestos is a fibrous mineral and may consist of any one of a number of silicates. The most common, chrysotile, is a hydrated magnesium silicate; crocidolite (blue asbestos) is a sodium iron silicate; and amosite and anthrophyllite are magnesium iron silicates.

Asbestos is used in a variety of products where a fibrous material resistant to heat or chemicals is needed. Long fibers are used in making textiles, such as cloth, braid, rope and theatre curtains. The shorter fibers, combined with an agglomerating agent, are employed in the manufacture of cardboard, cements, covering and insulating agents, felt, paper, tires, and varnishes.

HARMFUL EFFECTS Inhalation of asbestos dust may cause a chronic lung disorder known as "asbestosis". Usually several years following initial exposure, the worker will gradually notice shortness of breath, tendency to cough, with thick expectoration, and weight loss. Chest films reveal progressive changes in the lungs, known as "pulmonary fibrosis". Other workers have shown a tendency to thickening of the pleural linings, with calcification and fluid formation.

It is definitely established that asbestos-exposed workers show a high incidence of lung cancer as well as a rare malignancy of the pleural or peritoneal linings, known as "mesothelioma".

MAXIMUM ALLOWABLE CONCENTRATION (EIGHT HOUR TIME WEIGHTED AVERAGE) Using the membrane filter method at 430X phase contrast magnification, the maximum allowable concentration is two fibers greater than five microns in length per milliliter of air. (It is anticipated that this level will be reduced to 0.5 in the future.)

PROTECTIVE MEASURES Asbestos dust should be controlled by local exhaust or wet methods at the point of origin in so far as possible. The operation dispersing the dust should be isolated, controlled or so changed as to eliminate the dispersion of dust.

If workers must be stationed in areas where the maximum allowable concentration is exceeded, air supplied hoods, helmets or respirators should be worn. The type of respiratory protection needed will depend upon the fiber concentrations found. For exposures to fiber concentrations above 2 fibers greater than 5 microns in length per milliliter but not exceeding 20 such fibers, air purifying respirators must be used. When the fiber concentration is between 20 and 200 fibers greater than 5 microns in length per milliliter, a powered air purifying respirator must be used. When the fiber concentration exceeds 200 fibers greater than 5 microns in length per milliliter, a type "C" positive pressure supplied air respirator must be used. All respirators shall be selected from those approved by the National Institute for Occupational Safety and Health (NIOSH). Please refer to bulletin entitled, "Respirators Care and Maintenance Program, " Respiratory Protection Data Sheet No. 31.

MEDICAL CONTROL A pre-employment physical examination with special emphasis on pulmonary findings should be given. Pulmonary function tests ($FEV_{1.0}$ and FVC) and a full-size chest film (14 in. x 17 in.) should be required for all personnel to be exposed to asbestos dust. Such pulmonary function tests, X-ray films and physical examinations should be repeated at regular intervals (interval dependent upon exposure level) during the employee's exposure in order to detect early cases.

The diagnosis of asbestosis may be facilitated by the demonstration of "asbestos bodies," often with a characteristic stub-like appearance, brownish in color due to iron, and found in lung tissue or sputum. However, the presence of asbestos bodies alone does not justify the diagnosis of asbestosis. An unusual feature of the physical examination of a person with asbestosis is the presence of fine crepitant râles at the lung bases (so-called "asbestos râles").

Most of the recorded cases of lung cancer among asbestos workers were in cigarette smokers. Smoking by workers exposed to asbestos dust should be actively discouraged.

TREATMENT There is no specific treatment known for asbestosis. Removal from exposure is desirable.

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No. 1352 Supersedes No. 1265 August, 1983

CR 373 83

MICA

HAZARD CLASSIFICATION DUST HARMFUL - May cause pneumoconiosis.

GENERAL Mica is a mineral of varying chemical composition but is essentially composed of silicates of alumina and alkali metals (potassium, sodium) or other bases (magnesium, iron, lithium). The most common forms of mica are muscovite (white potassium mica), phlogopite (magnesium mica), lepidolite (aluminum, potassium, lithium fluorosilicate), and biotite (a black mica). Mica has a great many diversified industrial uses, such as a substitute for glass in cases where heat resistance is essential and for certain components of electrical equipment. The debris and mica dust are used in the pottery industry as a glaze and in the manufacture of decorative papers. In the chemical industry mica forms an ingredient of certain varnishes, enamels, special lubricants, and explosives. It is also used in the manufacture of paper and cloth for insulating purposes.

HARMFUL EFFECTS Mica dust may act as a mechanical irritant of the respiratory passages, the eyes and skin. Mica dust may cause fibrosis of the lungs even in the absence of free silica. Signs and symptoms of a pulmonary condition similar to silicosis known as micosis have been observed both clinically and experimentally.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure - 20 million particles of mica containing less than 1% free silica per cubic foot of air. If the free silica percent is greater than 1%, use free silica formula for determining the maximum allowable concentration.

PROTECTIVE MEASURES Mica dust should be controlled at the point of origin by the use of local exhaust systems or wet methods. Operations dispersing excessive quantities of dust should be isolated or enclosed or so changed as to eliminate the dispersion of the dust. Respirators are recommended only as a last resort. If used, respirator should be Type A, approved by the U.S. Department of Health, Education and Welfare, National Institute for Occupational Health and Safety (NIOSH).

MEDICAL CONTROL In view of reported cases of pneumoconiosis in workers handling clean mica, a reasonable medical control program should be followed, to include:

(1) Pre-employment physical examination, including chest X-ray on full size film and ventilatory function tests (FEV_1 and FVC).

(2) Chest X-rays and ventilatory function tests every three years.

(3) Individuals with a past history of tuberculosis or other lung diseases should not be allowed to work in an atmosphere containing mica dust.

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No. 1290 Supersedes No. 1171 March, 1980

PUMICE

HAZARD CLASSIFICATION An inert dust.

GENERAL Pumice is a glassy volcanic lava with a cellular structure brought about by steam or other volcanic gases. Pumicite is a volcanic dust of about the same composition which can be used for the same purposes as ground pumice. Pumice may be considered as an aluminum silicate with varying amounts of iron, magnesium, calcium, sodium and potassium. Little if any silica in the free form is usually present. Some varieties, such as Lapari pumice, may have between 1 to 5% free silica. In lump form, pumice is used as an abrasive for rubbing down wood, metal surfaces and paint and varnish finishes. Ground pumice and pumicite are used in many domestic and other cleaning, scouring and polishing preparations, such as hand soaps and silver and other metal polishes. The ground pumice is also used in finishing dental appliances.

HARMFUL EFFECTS Present evidence indicates that pumice in itself will not cause a disabling pneumoconiosis. However, excessive atmospheric concentrations of this dust may aggravate any respiratory ailment that may be present. The percent of free silica in the pumice is of utmost importance in determining the potential hazard. Pumice samples should be analyzed to determine the free silica content.

MAXIMUM ALLOWABLE CONCENTRATION For continuous exposure to respirable dust - Impinger Method - 30 million particles of pumice per cubic foot of air. Mass Respirable Method - 5 mg. of pumice per cubic meter of air. **If the free silica** content exceeds 1%, then the free silica standard should be used.

PROTECTIVE MEASURES Excessive concentrations of pumice dust should be controlled at the point of origin by the use of local exhaust systems or wet methods. The operation producing the dust should be isolated, enclosed or so changed as to eliminate the dispersion of dust. **If a hazardous exposure exists, dust respirators approved by the U.S. Department of Health, and Human Services, National Institute for Occupational Safety and Health, (NIOSH), Testing and Certification Branch (TCB), should be used.**

MEDICAL CONTROL As in all dust exposures, careful attention should be paid to respiratory diseases which may be aggravated by dust inhalation. A pre-employment medical examination including pulmonary function tests and a chest X-ray on full size film are recommended for prospective employees. Follow-up pulmonary function tests and chest X-rays should be given every five years. If the free silica content exceeds 1%, then the medical control program should conform to the requirements for free silica dust.

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No. 1321 Supersedes No. 1239 September, 1981

MASS. MAT. 2: RU5 no. 5 rev.

TALC

HAZARD CLASSIFICATION DUST HARMFUL--MAY CAUSE PNEUMOCONIOSIS

GENERAL Pure talc mineral is a hydrous magnesium silicate with the formula $H_2Mg_3(SiO_3)_4$. It is usually a secondary mineral resulting from the alteration of other magnesium silicates or carbonates, such as serpentine, tremolite and silicious dolomites. The characteristics of the mineral deposits vary widely from pure talc, according to the mineralogy involved. Some deposits may contain varying amounts of tremolite, chrysotile, dolomite, anthophyllite, pyrophyllite or serpentine. The deposits may also contain varying amounts of metals, such as iron, nickel, cobalt, chromium and manganese, as associated minerals, as well as silica (quartz). Talc has a characteristic soapy feeling and a pearlyluster. It may be pure white, silvery white, gray or green, and when impure, yellow, brown or reddish. The most common commerical variety is a massive, foliated or granular type, but it may also occur in a micaceous or in a fibrous form. Soapstone is a closely related substance, being essentially an impure talc. Tremolite, calcium magnesium silicate, and serpentine, a hydrated magnesium silicate, change over to talc in nature. These compounds may be mined with it and subsequently ground and sold with the talc.

It is important to note that the term "talc" as used commercially refers primarily to physical properties rather than to a specific material.

The value of the talc depends chiefly on its usefulness as a filler, inert extender, dusting powder, and absorbent.

HARMFUL EFFECTS Prolonged inhalation of talc dust in high concentrations may lead to pneumoconiosis, also called talcosis, with resultant shortness of breath, cough, weight loss, fatigue and limitation of activity associated with chronic lung disease. X-rays of the lungs in such cases show a finely distributed granulation or nodulation on a hazy background, which differs somewhat from the picture seen in silicosis. Excessive exposure to fibrous talc may result in lung cancer and mesothelioma.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure to respirable dust/fibers

Talc (nonasbestiform) - 2 mg. per cubic meter, respirable dust

Talc (containing asbestos fibers) - Use asbestos TLV

PROTECTIVE MEASURES A less harmful material should be substituted for the talc, or the dust should be controlled via local exhaust or wet method at the point of origin. The operation dispersing the dust should be isolated or enclosed, if possible, or the procedure so changed as to eliminate the dispersion of the dust. Respirators are recommended only when other dust control methods are not practicable. Respirators approved by the U.S. Department of Human Services, National Institute for Occupational Safety and Health (NIOSH), Testing and Certification Branch (TCB), should be used against the inhalation of pneumoconiosis-producing dust.

MEDICAL CONTROL Pre-employment and periodic physical examinations, including a full plate (14 in. by 17 in.) X-ray of the chest, should be required of all employees who may be exposed to talc ducts in concentrations approaching the maximum allowable level. In addition, pulmonary function tests, such as timed vital capacity and forced vital capacity, should be required, since impaired pulmonary function may precede X-ray changes.

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No. 1392 Supersedes No. 1324 July, 1986

GRANITE

HAZARD CLASSIFICATION DUST – VERY HARMFUL – MAY CAUSE SILICOSIS.

GENERAL Granite is a crystalline, plutonic rock composed largely of quartz and feldspar, usually with some mica and occasionally hornblende. It is classified as acid rock. Good granite is usually either gray or reddish, since granites of these colors are composed of minerals that are resistant to weathering. The black or greenish granite is less durable. On weathering, the color changes to a yellowish shade. Granite contains silica in both the combined and free forms (quartz). The average free silica content of granite is about 35%. Granite is quarried and after cutting, shaping, and polishing is used for monuments, curbing, and building stone.

HARMFUL EFFECTS Exposure to granite dust may cause silicosis, a disease of the lungs in which normal lung tissue is replaced by fibrous tissue. The signs and symptoms of silicosis are: Shortness of breath, cough, weight loss, easy fatigability and decreased chest expansion. Silicosis makes the patient increasingly susceptible to lung infections, especially to pulmonary tuberculosis.

MAXIMUM ALLOWABLE CONCENTRATION For continuous exposure to respirable dust--Light Field Dust Counting - Millions of particles per cubic foot (MPPCF) based upon $\frac{300}{\%\ \text{Quartz} + 10}$

Mass Respirable Method - $\frac{10}{\%\ \text{Respirable Quartz} + 2}$

PROTECTIVE MEASURES **The dust should be controlled at point of origin by use of local exhaust systems or wet methods. The operation dispersing the dust should be isolated or enclosed or the operation so changed as to eliminate the dispersion of the dust. A combination of one or more of the above methods may be employed. Refer to Bulletin Nos. 121, 122, 437, 681; Ventilation Data Sheet No. 8; and "Dust Control in the Granite Cutting Industry", Nos. 187, 189, and 191.**

Filter respirators should be used only for short periods of time and where it is impractical to provide engineering control. These respirators should be of a type approved by the U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, (NIOSH), Testing and Certification Branch (TCB).

MEDICAL CONTROL Pre-employment physical examination, including pulmonary function test ($FEV_{1.0}$ and FVC) and a full plate (14 in. x 17 in.) X-ray of the chest, should be required of all employees where exposure to granite dust will be encountered.

Individuals with a history of tuberculosis should not be placed in an excessively dusty atmosphere. Periodic examinations, including the pulmonary function tests and a full plate (14 in. x 17 in.) X-ray of the chest, should be required at least annually of all persons employed in dusty operations.

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SILICON CARBIDE

HAZARD CLASSIFICATION DUST MAY BE HARMFUL--MAY CAUSE PNEUMOCONIOSIS.

GENERAL Silicon carbide, a synthetic abrasive, is manufactured by heating a mixture of coke, silica sand, sawdust and sometimes sodium silicate in an electric furnace. Silicon carbide is used in the manufacture of abrasive wheels. It has also been used in powder or in molded forms as a substitute for emery in polishing, sharpening and pointing metals; cutting, polishing and engraving glass; polishing of diamonds and other precious gemstones and mother of pearl; polishing of leather, marble and hard stones, e.g., granite; and mounting of drilling and boring machines in quarries and mines.

HARMFUL EFFECTS Although it has not been definitely established that silicon carbide will produce harmful effects, recent literature indicates that it may cause pneumoconiosis. Inhalation of this dust will not produce massive fibrosis; but, like silica, silicon carbide reportedly may reactivate an arrested tuberculous lung lesion.

MAXIMUM ALLOWABLE CONCENTRATION **For occupational exposure, 30 million particles of silicon carbide per cubic foot of air or 10 milligrams of silicon carbide per cubic meter of air of total dust< 1% quartz, or, 5 milligrams of silicon carbide per cubic meter of air for respirable dust.**

PROTECTIVE MEASURES **Excessive concentrations of silicon carbide dust should be controlled at the point of origin by the use of local exhaust systems or wet methods. The operation dispersing the dust should be isolated, enclosed or so changed as to eliminate the dispersion of the dust. The use of approved Type A dust respirators is recommended only where it is not possible to institute adequate engineering controls.**

MEDICAL CONTROL All workers to be employed in excessively dusty operations should be given pre-employment physical examinations, including pulmonary function tests ($FEV_{1.0}$ and FVC) and full plate (14 in. by 17 in.) chest X-rays, to rule out pre-existing lung disease. In **addition, all workers should have annual physical examinations, including the pulmonary function tests, and full plate (14 in. by 17 in.) chest X-rays every two years.**

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No. 1304 **Supersedes No. 1228** **July, 1980**

ALUMINUM OXIDE

HAZARD CLASSIFICATION DUST MAY BE HARMFUL--MAY CAUSE MILD PNEUMOCONIOSIS.

GENERAL Aluminum oxide, a synthetic abrasive, is made by fusing bauxite, a natural aluminum ore, in an electric furnace. Although not as hard as silicon carbide, it is employed extensively in industry for its abrasive properties, as in the manufacture of grinding wheels. It is also used as a refractory in laboratory ware, in the blast cleaning of metal castings, and in stone cutting and polishing. Aluminum oxide fume may be given off during welding operations involving aluminum metal.

HARMFUL EFFECTS It has not been definitely established that aluminum oxide in itself will cause harmful effects. However, the literature to date indicates that prolonged exposure to high concentrations of the dust or fume of this substance may cause pneumoconiosis.

MAXIMUM ALLOWABLE CONCENTRATION **For continuous occupational exposure to respirable dust--impinger method--25 million particles per cubic foot of air, or total mass method - 10 milligrams per cubic meter of air.**

PROTECTIVE MEASURES Grinding wheels made of aluminum oxide should be hooded and provided with local exhaust ventilation, in accordance with the specifications contained in Bulletin No. 617, "Standard Hoods for Grinding, Buffing, and Polishing." When aluminum oxide is used as an abrasive in blast cleaning within a blasting room, the operator should be protected with a positive pressure blasting helmet approved by the U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, (NIOSH), Testing and Certification Branch (TCB).

Other operations dispersing aluminum oxide dust should be isolated, enclosed, or so changed, e.g., by wet methods, as to eliminate dispersion of the contaminant. The use of approved Type A dust respirators is recommended only where it is not possible to institute adequate engineering controls.

MEDICAL CONTROL Pre-employment and periodic physical examinations, including pulmonary function ($FEV_{1.0}$ and FVC) and chest X-ray should be required of all employees who may be exposed aluminum oxide dust in concentrations approaching the maximum allowable level.

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No. 1320 Supersedes No. 1229 September, 1981

FIBROUS GLASS

HAZARD CLASSIFICATION May cause irritation of the skin. eyes. upper respiratory tract. and other mucous membranes.

GENERAL Fibrous glass is produced as a wool-type product and as a textile fiber. Textile fibers are usually continuous filaments. often referred to as yarns. and are formed in unending fibers. whereas the glass wool fibers are formed in varying lengths. Nominal fiber diameters are generally in the range of .03 to .1 mm. although all grades contain fibers less than one micrometer in diameter. The fibers are usually coated with binders. lubricants. sizers. and coupling agents to bind the individual fibers together so that the final form is established and maintained. to protect the surface of each fiber. and to serve as a bonding agent if the fibers are to be incorporated in a matrix of resins or other materials. The wool-type product is used primarily for thermal and acoustical insulation for domestic. commerical and industrial structures. including products used inside these buildings. and also finds great use as a component of manufactured products. The textile yarns are used in decorative and home furnishings. and as reinforcements for plastic and rubber.

HARMFUL EFFECTS Careful medical observations have failed to reveal any evidence that fibrous glass leads to pneumoconiosis. but it can cause mechanical irritation of the skin and mucous membranes including the upper respiratory tract. Consideration should be given to the potential harmful effects of other substances incorporated in the fibrous glass product. Animal experiments have shown that glass fibers less than 1.0 micrometer in diameter and more than 10 micrometers long can cause fibrosis and mesothelioma. Air concentrations of these harmful fibers in the manufacturing plant have been found to be less than 0.2 fibers per milliliter of air. The lack of clinical illness in fibrous glass workers may be due to these low concentrations.

MAXIMUM ALLOWABLE CONCENTRATION For continued exposure to fibrous glass-5 milligrams of dust per cubic meter of air.

PROTECTIVE MEASURES The dust should be controlled at the point of origin by the use of local exhaust systems or wet methods. The operation generating or dispersing the dust should be isolated or enclosed. if possible. or the operation so changed as to eliminate the generation and dispersion of the dust. The use of protective clothing may be necessary. Adequate washing facilities should be provided. Personal hygiene is important. Respirators approved by the U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, (NIOSH), Testing and Certification Branch (TCB). for protection against the inhalation of pneumoconiosis-producing dusts should be used for short exposures to excessive dust concentrations.

MEDICAL CONTROL Fibrous glass once imbedded into the skin should be removed by use of soap and water. Irritations to the skin should be treated with mild lotions. such as calamine. Any evidence of spreading skin irritations requires careful medical attention since other substances. such as resins. may be the cause of dermatitis. Lung function evaluation should be performed at three year intervals on persons exposed to fibrous dust of respirable size.

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No. 1327 Supersedes No. 1286 August , 1981

ASBESTOS BRAKE LINING FACT SHEET

Background

Millions of asbestos fibers can be released during brake and clutch servicing operations. Many of the fibers are small enough to be invisible and can be breathed in, carried home on clothing, or swallowed when eating or smoking. Asbestos fibers persist in the air long after brake jobs are done. With any air movement, settled fibers are resuspended in the air.

EPA has banned the use of asbestos for uses such as insulation or fireproofing however it has not banned asbestos use in products such as brake pads. In light of the increasing evidence of asbestos related disease in mechanics and their families, it is imperative that auto shops take precautions to prevent asbestos exposure.

Health Effects

There is no known safe level of asbestos exposure. Increased exposure to asbestos leads to increased chances of developing asbestos related disease. It often takes 15 - 30 years after exposure to develop an asbestos related disease. This can give a false sense of security since the disease can occur even many years after exposure has ceased. Medical examinations are generally not helpful since by the time asbestos related disease is diagnosed it is often too late for treatment. The best way to control asbestos related disease is to prevent exposure. Diseases caused by asbestos exposure are summarized below.

Asbestosis - is a scarring of the lung tissues leading to the shortness of breath and decreased oxygen transfer to the blood. Asbestosis becomes more debilitating with time and increased exposure and often leads to heart failure. Nearly one half of mechanics working for years without control measures can develop this disease.

Lung Cancer - is currently the leading cause of death from asbestos exposure. Even brief exposures to asbestos can lead to this disease. The risk of getting lung cancer if exposed to asbestos is 5 times greater than a non exposed person. The risk is greatly increased to approximately 50 times in people who smoke and are exposed to asbestos. You can significantly decrease your risk of getting lung cancer from asbestos by not smoking.

Mesothelioma - is an almost always fatal cancer of the chest or abdominal lining. It can be caused even with low levels of asbestos exposure. This cancer has been found in mechanics, their wives and their children.

Other Cancers - such as voice box, intestinal and stomach cancers have been associated with asbestos ingestion.

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Approved by the State Purchasing Agent

Work Practices to Prevent Asbestos Exposure

Blowing off brake drums with an air hose compressor can release up to 16 million fibers per cubic meter around the mechanics face. Even hitting the brake drum with a hammer can release over a million fibers. Because the exposure levels are so high, OSHA has prohibited the practice of using an air compressor alone under the new OSHA standard.

Other methods which have been tried over the years to decrease exposure include the use of wet rags, brushes, liquid squirt bottles, solvent spray systems and garden hoses. Air tests done during use of these methods have all been elevated and in most cases have still been above the OSHA action level. These methods will not prevent asbestos exposure.

Currently the only good method to minimize asbestos exposure is to use an enclosed system with a special vacuum designed to trap asbestos fibers. The features of the system are described below. Note - Shop vacuums should never be used to collect asbestos dust since the filters are not fine enough to trap asbestos fibers. Fiber levels can actually be increased when a shop or regular vacuum is used.

Enclosure Equipment for Cleaning Brake Drums

1. An enclosure system slips over the brake assembly and forms a tight seal against the backing plate. The walls of the enclosure are clear so that the worker can see the brake assembly.

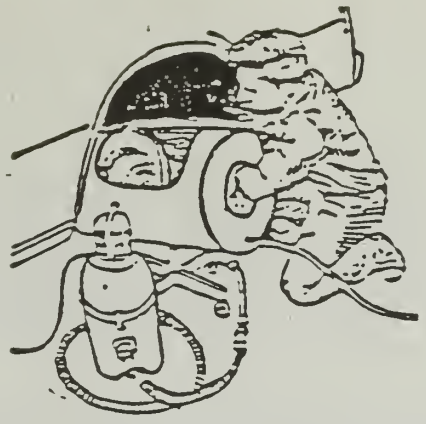
2. Non permeable gloves are attached to the front panel so that the worker can access the assembly and equipment.

3. A special HEPA vacuum system attached to the enclosure traps the small asbestos fibers and prevents release of fibers to the air. This vacuum is the only type which will capture asbestos fibers.

4. A compressed air hose can then be used inside the enclosure to blow off all dust.

Features to look for when purchasing enclosed system:

- gauge to tell when filter needs to be changed
- safe filter change method (some models have vacuums which will stay on while the filter house is open so that asbestos exposure is minimized)
- documentation of air testing done during system use. Samples should have been analyzed by TEM (transmission electron microscopy) and should show no visible asbestos fibers released during system use.



Enclosed Brake Drum System

How to Use Enclosure Equipment for Cleaning Drum Brakes

(taken from EPA document -
Guidance for Preventing Asbestos Disease Among Auto Mechanics June 1986)

Steps for using this type of equipment on drum brakes are simple:

1. Check that the hose is securely fastened to the HEPA vacuum container and to the brake enclosure. Also check that the vacuum container seals and clips are in proper functioning order according to the manufacturer's instructions.

2. Remove the wheel.

3. Turn on the asbestos vacuum cleaner.

4. Place the enclosure over the drum, making sure it forms a tight seal behind the backing plate.

5. Place hands into the attached rubber gloves.

6. Remove the brake drum. Some equipment allows use of a hammer or other tools inside the enclosure for drums that are hard to remove.

7. Blow dust off the drum brake assembly using the air gun attachment inside the enclosure.

8. Blow dust off all inside surfaces of the enclosure toward the vacuum exit using the air gun attachment inside the enclosure.

9. Remove the enclosure and turn off the vacuum cleaner.

If grease accumulates on the inside surfaces of the enclosure, clean according to the manufacturer's instructions with a soft cloth and with the vacuum running. Dispose of the cloth according to OSHA regulations (29 CFR 1910.1001 (h)(2)). This cloth should not be handled with bare hands.

Additional Precautions

No one should be allowed to eat, drink or smoke in the work area and should be required to wash hands before eating. Ideally, work clothes should not be worn home but should be specially laundered. Anyone who works with asbestos should quit smoking. Anyone who has been exposed to asbestos should be encouraged to stop smoking.

Air purifying respirators with HEPA filters and disposable clothing should be worn when changing the vacuum filters. The respirator should be checked to assure proper fit ("fit-tested") according to the manufacturers guidelines. Note - disposable respirators and dust masks are no longer allowed under the new OSHA standard.

Disposal

All asbestos waste including rags, brake pads, vacuum filters and disposable clothing must be properly sealed in impermeable containers and labelled as follows:

DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD

Contact DEQE for further information and for the location of the nearest landfill to accept asbestos waste.

DEQE Office Numbers

Northeast/Metropolitan Office (617) 935-2160
Central Mass Office (617) 792-7653
Southeast Mass Office (617) 947-1231
Western Mass Office (413) 785-5327

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No. 1397 February 1987

WORKING WITH SPRAY-ON MATERIAL

If it is necessary to work in an area with spray-on asbestos material the following precautions should be taken.

Equipment List

1. NIOSH/MSHA approved respirators with HEPA filters.
2. Disposable clothing, head coverings and booties.
3. HEPA vacuum.
4. Spray encapsulant (available through asbestos abatement or safety suppliers) to seal in asbestos fibers once material is cut into.
5. Polyethylene sheeting and duct tape.
6. Pocket knife or scissors.
7. Asbestos Warning signs.
8. Spray bottle filled with water and surfactant. (Refer to manufacturer's instructions for mixture ratio.)
9. Water bucket.
10. Asbestos disposal bag.
11. Other tools necessary to perform particular job.

1. Working above suspended ceiling where spray-on material is present (Note - only equipment listed 1-3 above is needed if asbestos is not to be cut into.)
   a. Wear approved respirators.
   b. Wear disposable clothing.
   c. Gently remove the suspended ceiling tile.
   d. HEPA vacuum any debris on top of the ceiling tile.
2. Cutting into spray-on material (NOTE - No more than three square feet of material should be cut into. If a large area of spray-on is to be cut into, hire an asbestos removal contractor according to the DOH "Minimum Bid Specifications".

a. Isolate the work area by sealing off the doors, walls and floor in the immediate vicinity with polyethylene sheeting and duct tape.

b. Establish an entry way by doing the following:

   1. Place a 5-6 foot strip of duct tape vertically in the middle of the polyethylene over the doorway.

   2. Cut a slit through the duct tape and polyethylene to create an opening. (The duct tape will reinforce the opening.)

   3. Place a flap of polyethylene on each side of the slit piece of polyethylene by duct taping only the top of each flap.

c. Post signs warning of asbestos hazard outside the sealed area.

d. Wear an approved respirator and disposable clothing.

e. Thoroughly wet both the area of spray-on to be cut and the spray-on immediately around this area. (Use water containing surfactant if possible). NOTE - Use a fine mist and gradually soak the material since a strong stream of water can disperse fibers.

f. Holding or placing a plastic bag or bucket under the area, gently cut into the material so that most of the debris falls into the bag or bucket.

g. Use a spray encapsulant in the cut area to seal the asbestos. (Refer to manufacturer's instructions for details.)

h. Check the area for asbestos debris. Clean up any asbestos debris using a special HEPA vacuum. If the facility does not have this type of vacuum, the debris should first be thoroughly wet using a light mist of water from a spray bottle. A plastic bag, inverted over the hand like a glove, can be used to pick up chunks of debris. Grab the wet debris with the bag then invert the bag back over the hand so that material is inside bag. A wet rag can then be used to pick up residual dust. Place this rag inside the plastic bag and seal the bag well with masking tape. Contact the Department of Quality Engineering (DEQE) for proper disposal practices.*

i. Clean all tools, bucket etc. by rinsing off debris with spray bottle into the asbestos waste bag.

j. Fold polyethylene on walls and doors inwards so that any debris falls on the polyethylene on the floor.

k. Fold polyethylene on floor inwards.

l. Remove disposable suit and dispose of suit and polyethylene in labelled asbestos waste bag.

m. Twist top of bag and seal with duct tape. Double bag debris and contact DEQE for disposal practices.*

n. Remove and clean respirator.

* DEQE Office Numbers

Northeast/Metropolitan Office	935-2160
Central Mass Office	792-7653
South East Office	947-1231
Western Mass Office	413-785-5327

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No. 1399 February 1987

SAFE REPAIR PRACTICES FOR ASBESTOS PIPE AND BOILER INSULATION

Small sections of moderately damaged pipe or boiler insulation can often be easily repaired using a material such as rewettable fiberglass cloth. Rewettable fiberglass cloth is a canvas-like material which is impregnated with glue. When wet it conforms to the insulation contours and thus can be placed on damaged insulation to seal off holes, tears, damage or exposed ends. When dry, the material hardens thus decreasing the potential for further damage. Insulation which is subject to regular contact or water damage should also be mechanically enclosed with an appropriate material (i.e. wood boxes or metal or plastic jackets) after repairing the damage with rewettable fiberglass cloth. Note - Duct tape is not appropriate for repair of asbestos insulation since it tends to dry out and can pull the asbestos material with it when it peels off.

Procedure for repair

1. Wear NIOSH/MSHA approved respirator and disposable clothing.

2. Thoroughly wet damaged area with a light mist of water using a spray bottle.

3. Wet a piece of rewettable fiberglass cloth thoroughly and place over damaged area, being careful to enclose any exposed insulation.

4. Clean up any asbestos debris using a special HEPA vacuum. If the facility does not have this type of vacuum, the debris should first be thoroughly wet using a light mist of water from a spray bottle. A plastic bag, inverted over the hand like a glove, can be used to pick up chunks of debris. Grab the wet debris with the bag then invert the bag back over the hand so that material is inside bag. A wet rag can then be used to pick up residual dust. Place this rag inside the plastic bag and seal the bag well with masking tape. Contact the Department of Environmental Quality Engineering (DEQE) for proper disposal practices.*

5. Remove disposable suit and place in asbestos disposal bag. Double bag all waste and dispose according of according to DEQE.*

6. Remove and clean respirator according to manufacturer's instruction.

7. When the rewettable fiberglass cloth has dried paint over the cloth with a paint which has an appropriate fire rating.

* DEQE Office Numbers

Northeast/Metropolitan Office 935-2160
Central Mass Office 792-7653
Southeast Office 947-1231
Western Mass Office 413-785-5327

Massachusetts Department of Labor and Industries
James F. Snow, Commissioner

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Richard Levine, Director

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No. 1400 Supercedes No. 1359 February 1987

SUSPECT MATERIALS SAMPLE COLLECTION

The Division of Occupational Hygiene does not recommend cutting into a well wrapped pipe or boiler covering solely for the purpose of sample collection since this creates an unnecessary exposure risk. If the material has to be removed or cut into for another reason, a sample should be sent in to D.O.H. for analysis. Suspect material is assumed to be asbestos until analyzed.

SAMPLE CONTAINER AND LABELING

1. Clear plastic bags or sealable containers (i.e. - film canisters) should be clearly labelled in pen with:

    1. Date
    2. Building
    3. Agency
    4. Sample location
    5. Type of covering (i.e. - pipe covering, boiler covering, spray-on)

    Note that plastic bags should be labelled prior to sampling in case the pen makes a hole in the bag.

HOW TO COLLECT A BULK SAMPLE

1. Only those persons needed for sampling should be in the area.

2. A NIOSH/MSHA approved respirator should be worn. (i.e. - reusable half-face respirator)

3. The material should be sprayed with a <u>light</u> mist of water from a spray bottle to minimize fiber release during sampling.

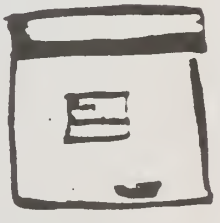
4. If a sealable container is used, hold the container as far as possible from the face and obtain a sample by penetrating the material with the container using a twisting motion.

5. If a bag is used, turn the bag inside out over your hand. Using the bag like a glove, grab a piece of material. Still holding the material, invert the bag over your hand so that the material is inside the bag.

1. Invert labelled bag over hand

2. Using bag like a glove, pick up a piece of material

3. Invert bag back over hand so material is inside



4. Seal bag with masking tape

6. The sample container must be well sealed with masking tape.

7. Clean up any asbestos debris using a special HEPA vacuum. If the facility does not have this type of vacuum, the debris should first be thoroughly wet using a light mist of water from a spray bottle. A plastic bag, inverted over the hand like a glove, can be used to pick up chunks of debris. Grab the wet debris with the bag then invert the bag back over the hand so that material is inside bag. A wet rag can then be used to pick up residual dust. Place this rag inside the plastic bag and seal the bag well with masking tape. Contact the Department of Environmental Quality Engineering (DEQE) for proper disposal practices.*

Important Considerations when Sampling

1. The sample should be approximately the size of a quarter.

2. Samples should be collected from damaged or exposed areas so as not to create further damage to the material.

3. A core sample must be taken since there may be different materials in each layer. (i.e. - penetrate and sample all layers of the material)

4. Three samples should be taken from three different areas for any spray-on material since the material is often not sprayed on evenly and one sample may not be representative of the material.

* DEQE Office Numbers

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X - RAYS

GENERAL X-rays were discovered by Wilhelm Roentgen in 1895. They are formed when a stream of electrons moving at a high velocity impinge on a metal or other target. A vacuum tube with its cathode (source of electrons), its anode (target), and accelerating potential (anode voltage) is the most widely used source of X-rays. X-ray tubes are especially designed to emit radiation, but any electronic vacuum tube may produce some radiation.

X-rays consist of electromagnetic radiation in the length range between 0.1 and 10 angstroms. The amount of X-ray produced and its penetrating power will depend on the tube voltage, tube current, and target material.

Because X-ray is a penetrating ionizing radiation, it finds many uses in industry, particularly in nondestructive testing. Flaws in castings or welds, alignment of parts in sealed components, or the presence of foreign material may be detected by passing X-rays through the object onto film or a fluorescent screen.

Crystalline structure of materials may be studied by measuring the angles that X-ray is diffracted from the material. The composition of material may be analyzed by measuring the characteristic secondary radiation emitted by the material.

X-ray is also used in industry for gauging the height of materials in containers, thickness of material, and density of material.

X-ray machines usually seen in industry are such that when there is no voltage on the anode and no tube current, there is no radiation. Materials exposed to X-rays will not possess residual or be radioactive in any way.

HARMFUL EFFECTS X-rays, as all forms of ionizing radiation, in sufficiently high doses will cause damage by injuring living cells. The effects of X-radiation, therefore, depend upon the type of cell injured, the dosage, and the length of exposure. Certain cells, such as immature cells, blood cells, and cells of the reproductive tissues are particularly sensitive.

Harmful results are more likely to occur from a large single exposure than from small repeated exposures; also, the effects on small areas of the body are less likely to produce harmful effects than the same dose on large areas.

The most severe damage is caused by heavy body radiation which may lead to signs of shock, dehydration, and evidence of widespread tissue damage within a few hours after radiation. Later fever and bone marrow suppression, with intestinal symptoms, ulceration, and diarrhea will follow. The patient with excessive radiation syndrome may succumb within a month or recover slowly. If repeated exposure to small doses occurs, there may be a prolonged period of latency, followed by serious damage to the skin (cancer) or bone marrow (aplastic anemia, leukemia) in certain individuals.

MAXIMUM PERMISSIBLE DOSE

Whole Body Gonads, lens of eye Head and trunk Active blood-forming organs	1.25 rems in any calendar quarter
All organs, including thyroid, other than those above	5.0 rems in any calendar quarter
Skin of whole body Thyroid	7.5 rems in any calendar quarter
Hands and forearms Feet and ankles	18.75 rems in any calendar quarter

Exposure of the Fetus of Fertile Women

During the entire gestation period, the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother shall not exceed 0.5 rem.

PROTECTIVE MEASURES **Distance**: The intensity of X-ray decreases as the square of the distance; for example, doubling the distance from the source decreases the intensity four times. Keep as great a distance as possible from the source of X-ray.

SHIELDING: X-ray intensity can be reduced by shielding: lead and concrete are most commonly used. The doors to shielded X-ray enclosures must* be electrically interlocked to the X-ray circuit. Do not remove any shielding that is provided. The shielding should be designed by one qualified in this field.

MONITORING: Adequacy of the protective measures must* be checked with appropriate radiation detecting instruments.

PERSONNEL MONITORING: Appropriate personnel monitoring devices must* be used if a person is likely to receive 25% of the above maximum permissible dose.

MEDICAL CONTROL See Bulletin No. 1143, "Medical Examination of Personnel Exposed to Ionizing Radiation".

REGISTRATION X-ray machines, devices, or equipment used in or by industrial establishments and related places of employment must be registered with the Massachusetts Department of Labor and Industries.

*Required by Regulations of Massachusetts Department of Labor and Industries - Industrial Bulletin No. 5, "Rules and Regulations for the Protection of the Health and Safety of Employees from Occupational Diseases Caused by Ionizing Radiation", dated December 15, 1978.

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ULTRAVIOLET RADIATION

GENERAL The visible region of the spectrum comprises only a small portion of the entire scale of radiant energy. Ultraviolet is one of the shorter radiations in the invisible region. The wave lengths for ultraviolet vary from about 180 to 400 millimicrons. Ultraviolet rays are found in sunlight, ionized gases, most incandescent bodies, oxyacetylene and electric welding, cutting and burning, cupola melting, open hearth and electric furnance operations, foundry pouring, lasers, germicidal lamps, and in fire boxes and kilns. Ultraviolet radiations are present in dangerous quantities in any combustion or incandescent body over 1800° F. Ultraviolet radiations are also produced by mercury vapor ares enclosed in plain glass or quartz tubes. The mercury vapor are that has a quartz bulb is a very powerful source of ultraviolet radiation.

HAZARDS (1) Exposure of the unprotected eyes to ultraviolet radiation may cause, depending on length of exposure, inflammation of various eye structures known as blepharitis, conjunctivitis, keratitis, and keratoconjunctivitis.

(2) Prolonged exposure to the skin may cause skin changes, such as tanning, blisters and irritation, following a latent period of six to 12 hours. Some authorities believe that prolonged exposure increases the risk of skin cancer. Ultraviolet radiation is known to improve some skin diseases but also to cause exacerbation in others.

RECOMMENDED THRESHOLD LIMIT VALUES

1. For the near ultraviolet spectral region (320 to 400 nm.) total irradiance incident upon the unprotected skin or eye should not exceed 1 mJ/cm^2 for periods greater than 10^3 seconds (approximately 16 minutes) and for exposure times less than 10^3 seconds should not exceed one J cm2 (1000 mJ/sec./cm^2).

2. For the actinic ultraviolet spectral region (200 - 315 nm.), radiant exposure incident upon the unprotected skin or eye should not exceed the values given in Table 1 within an eight-hour period.

3. To determine the effective irradiance of a broadband source weighted against the peak of the spectral effectiveness curve (270 nm.), the following weighting formula should be used:

$$E_{eff} = \Sigma E_\lambda S_\lambda \Delta_\lambda$$

where:

E_{eff} = effective irradiance relative to a monochromatic source at 270 nm. in W/cm^2.
E_λ = spectral irradiance in W/cm^2/nm.
S_λ = relative spectral effectiveness (unitless)
Δ_λ = band width in nanometers.

4. Permissible exposure time in seconds for exposure to actinic ultraviolet radiation incident upon the unprotected skin or eye may be computed by dividing 0.003 J/cm^2 by E_{eff} in W cm2. The exposure time may also be determined using Table 2, which provides exposure times corresponding to effective irradiances in $\mu W/cm^2$.

Table 1

Wavelength (nm.)	TLV (mJ/cm^2)	Relative Spectral Effectiveness $S\lambda$
200	100	0.03
210	40	0.075
220	25	0.12
230	16	0.19
240	10	0.30
250	7.0	0.43
254	6.0	0.5
260	4.6	0.65
270	3.0	1.0
280	3.4	0.88
290	4.7	0.64
300	10	0.30
305	50	0.06
310	200	0.015
315	1000	0.003

Table 2

Duration of Exposure per Day	Effective Irradiance, E_{eff} ($\mu W/cm^2$)
8 hours	0.1
4 hours	0.2
2 hours	0.4
1 hour	0.8
½ hour	1.7
15 minutes	3.3
10 minutes	5
5 minutes	10
1 minute	50
30 seconds	100
10 seconds	300
1 second	3,000
0.5	6,000
0.1 second	30,000

Note: The above threshold limit values are recommended by the American Conference of Governmental Industrial Hygienists. The levels listed do not apply to ultraviolet lasers. All the preceding levels apply to sources which subtend an angle less than 80°. Sources which subtend a greater angle need to be measured only over an angle of 80°.

ROTECTIVE MEASURES To afford eye protection, workers exposed to intensive ultraviolet radiation should be provided with and required to wear goggles, helmets, shields or masks equipped with colored lenses especially designed to exclude the kinds and intensities of [illegible] encountered. Clothing completely covering the body should be worn.

Booths or baffles should be provided to protect others working near by.

MEDICAL CONTROL The best medical control is prevention in the form of protection to eyes and skin and an educational program with repeated emphasis to the workers of the dangers of ultraviolet radiation.

If a short, heavy exposure to the unprotected eyes or what is called a "flash," occurs, the workers should be seen as soon as possible by a physician. Before the physician arrives, cold packs may be applied to the eyes to relieve pain. If treatment is started immediately, the pain, extent of injury and amount of lost time will be negligible.

A worker who after intensive exposure over a period of time complains of visual disturbances, skin irritation or a skin lesion which does not heal should be examined by a physician experienced in treating workers who show these symptoms.

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No. 1234 Supersedes No. 1192 April, 1980

INFRA-RED RADIATION

HAZARD CLASSIFICATION: Hazardous to vision

GENERAL The visible region of the spectrum comprises only a small portion of the entire scale of radiant energy. In the invisible region there are the longer and shorter radiations. Infra-red is one of the longer radiations, and the wave length for short infra-red varies from 780 to 1250 millimicrons; the wave length for long infra-red rays varies from 1250 to 100,000 millimicrons and above. Infra-red rays are found in sunlight, most incandescent bodies, in oxyacetylene and electric welding, cutting and burning, cupola tending, open hearth and electric furnance operations, foundry pouring, and looking into fire boxes and kilns. Infra-red lamps are also used in certain industries for drying and baking purposes. Infra-red rays are present in dangerous quantities in any combustion or incandescent body at a temperature over 1800° F. The higher the temperature, the more harmful they become.

HAZARD The greatest hazard of infra-red rays is damage to the unprotected eyes, which absorbs and transform these rays into heat energy. Continuous exposure will cause cloudiness of the lens (heat cataracts), cloudiness of the aqueous humor, and even permanent damage to the retina and choroid. Any one of these conditions leads to decreased vision and possible blindness. Mild exposures to infra-red will cause eye fatigue and headaches. Under the heading of hazards can also be classified the "temporary blindness" experienced by workers who intermittently look from high temperature incandescent bodies to comparatively dark surroundings. This "blindness" is due to the short period of time it takes the iris to contract when exposed to high intensities of light (one second) and the long periods of time it takes to expand when exposed to darker surroundings (7 seconds). It is this time interval of 7 seconds that provides the circumstances for tripping and stumbling accidents.

MAXIMUM ALLOWABLE CONCENTRATION To avoid possible delayed effects upon the lens of the eyes (cataractogenesis), the infrared radiation ($\lambda > 770$ nm) should be limited to 10 milliwatts per square centimeter (mW/cm^2).

PROTECTIVE MEASURES Workers exposed to infra-red radiation should be provided with and required to wear goggles, helmets, shields or masks, equipped with colored lenses especially designed to exclude the kinds and intensities of infra-red light to which the worker is exposure. Where continuous exposure exists, permanent baffles and shields should be erected to prevent the rays from reaching adjacent workers. In some instances spot cooling of employees should be employed.

MEDICAL CONTROL Medical control lies in prevention. An educational program should be in effect to inform the workers of the dangers of infra-red radiation to the unprotected eye. If a worker should complain of headaches, eye fatigue or decreased vision, he should be examined by an ophthalmologist for possible eye damage and treated accordingly.

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No. 1277 Supersedes No. 1055 April, 1983

MA13.2:R245

NOISE

GENERAL Noise may be defined as an unpleasant or disturbing sound that forces unwilling attention, causes unpleasant emotional reactions and the cessation of which gives one a distinct feeling of relief. Exposure to excessive noise is the price we pay for our modern civilization. The more noisy trades and industries include the metallurgical trades, the textile and felt industries, the transportation and communication industries, and the building trades. The effects of noise are governed primarily by intensity, frequency and tone. Intensity is usually measured in decibels, and the range of hearing extends from 0 to 120 decibels. At the latter figure sound is felt as well as heard and may be painful. Frequencies are usually measured in Hertz (cycles per second), and frequencies less than 30 and greater than 16,000 Hertz are not heard by the majority of adults. In addition, high pitched tones appear to be more noisy than low pitched tones, and loud noises within an enclosed space have a greater effect than similar noises in the open.

HARMFUL EFFECTS Sustained exposure to noise is a contributing factor to the following: Dizziness, ringing in the ears, chronic fatigue, decreased physical and mental efficiency, emotional disturbances and neuroses, and impaired hearing or deafness. Impaired hearing from acoustic trauma is characterized either by a slowly progressive hearing loss or, if there has been a sudden loud sound close to the ear, by an acute onset of a hearing loss. The deafness may be due to a ruptured eardrum, hemorrhage in the nervous tissue, a chronic inflammation and loss of elasticity of the eardrums with fibrous adhesions, or most often due to irreversible changes in the tiny hair cells located in the inner ear. If speech communication cannot be carried on except with difficulty, a "noise problem" is said to exist. The first sign of hearing loss, whether temporary or permanent, appears at 4,000 Hertz. An average person not exposed to excessive noise will have "impaired hearing," at age 65 due to aging. An average person exposed continuously to 90 to 100 dB (A) will have impaired hearing at age 30. Almost one half of all persons exposed to 100 dB(A) throughout their working life will be totally deaf by the time of retirement.

PERMISSIBLE NOISE EXPOSURES The following standards have been promulgated by the U.S. Department of Labor as measured on the A scale of a standard sound level meter at slow response. Sound level meters must conform as a minimum to the requirements of the American National Standards Institute (ANSI) for sound level meters, S1.4 (1971) Type S2A.

Duration Per Day, Hours	Sound Level dB A Scale, Slow Response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
¾	107
½	110
¼ or less	115*

*Ceiling value: No exposure in excess of 115 dB A Scale, Slow response.

GOVERNMENT DOCUMENTS COLLECTION
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IMPACT NOISE Exposure to impulsive or impact noise (variations in noise level maxima at intervals of more than one second) should not exceed 140 dB peak sound pressure level. These readings should be taken using an impact meter. For screening purposes a standard sound level meter set on its 130 dB range and on C Scale fast response may be used. If the reading is 125 dB or less, the impact may be considered to be less than 140 dB peak sound pressure level. If the reading is in excess of 125 dB, the operation should be resurveyed using an impact meter. Impulses at 140 dB shall be limited to 100 per day, with a ten-fold increase for each 10 dB decrease in the peak pressure of the impulse.

Note: The current noise standard is being reviewed by OSHA, and consequently the standard listed above may be modified in the near future.

PREVENTIVE MEASURES The old maxim that noise in industry is an indispensable nuisance which must be tolerated should be discarded. Noise exposure may be controlled by one or by a combination of the following methods:

1. Reduction in the intensity of noise produced at its source by careful acoustical design of new machines, modification of design of machines now in use, proper upkeep and repair of equipment, muffling of exhausts, and changes in methods of processing.

2. Reduction in amount of noise transmitted through air or building structures by increasing the distance between the work area and the source of noise, constructing barriers between the work area and the source of noise, sound-treating work area to reduce reverberation, and placing equipment on vibration mounts.

3. Revision of operational procedures by changing job schedules, rotating personnel, by remote or automatic operation of machines and equipment, and by limiting the exposure time.

4. Provision of personal protective devices, such as fitted ear plugs or ear muffs. Impregnated commercial fibrous materials of the disposable type may be used in borderline noise exposure areas.

MEDICAL CONTROL Hearing tests should be performed prior to assignment to jobs where a noise problem exists. A hearing conservation program should be established and maintained for employees who receive a daily noise dose equal to or exceeding 0.5, or are required to wear hearing protection. These tests should be repeated periodically, at least once a year. The audiometric measurements should be obtained in a technically suitable test room with a standard audiometer operated by trained personnel under medical supervison. Initial audiograms of the potentially exposed workers should be compared with their follow-up audiograms. Evidence of progressive hearing loss may necessitate additional preventive measures or transfer to work areas where a noise problem does not exist.

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No. 1138 Supersedes No. 1082 December, 1983

EXCESSIVE HEAT

GENERAL The ill effects of heat on the human body have been known for centuries. Under normal conditions, the body produces more heat than necessary to maintain the body temperature. It gains heat by foods ingested, radiation, convection and conduction. The excess heat is given off from the body by conduction, convection and radiation from the skin, provided that the temperature of the surrounding air and objects is lower than the body temperature. Excess heat can also be given off by evaporation of sweat, but this also is dependent on the surrounding temperature and the moisture in the air; the higher the humidity, the less evaporation. Air currents coming in contact with the body will hasten heat loss; however, if this air current is above the body temperature and if the humidity is high, it will have the reverse effect. A small amount of heat is also lost by exhalation. If the body is unable to lose sufficient heat by the above methods, then the body temperature will, of course, rise and may lead to the various forms of heat sickness.

HARMFUL EFFECTS Three fairly distinct effects may result from exposure to high temperature:

1. Heat cramps, in which the worker experiences severe painful muscular contractions of the arms, legs, hands and trunk. They are always preceded by marked sweating. The temperature may be above or below normal with a rapid pulse. Cramps are usually in the extremities and generally follow heavy exertion.

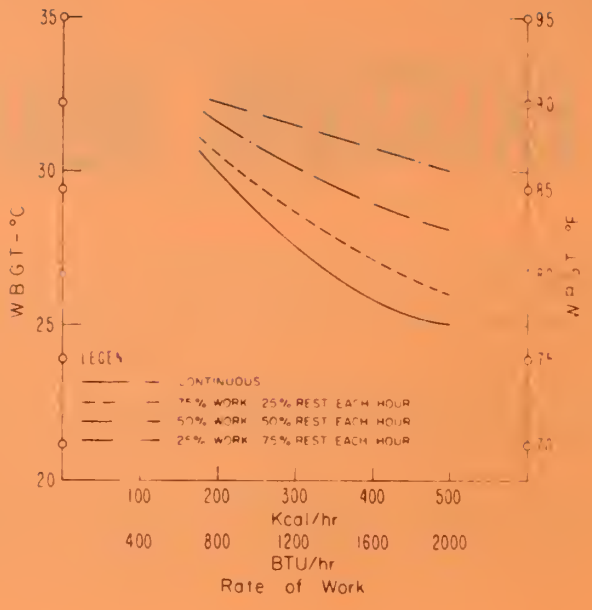
2. Heat exhaustion, in which the individual is pale, cold, clammy and weak to the point of exhaustion. The blood pressure is low, and the temperature may be above or below normal. Nausea and diarrhea may be present. The picture is that of surgical shock. This condition may be preceded or followed by heat cramps.

3. Heat stroke (sunstroke), in which the temperature is very high, with rapid pulse and deep respiration. Blood pressure is high and skin is hot and flushed. There may be unconsciousness, convulsions or deep coma. The onset may be gradual with mental excitement and dryness of mouth and skin, or may be sudden with delirium, stupor or coma. This condition has a death rate of 30% to 50%.

PERMISSIBLE HEAT EXPOSURE A single figure exposure limit cannot be assigned due to the interrelationship between ambient air temperature and workload. Both sources contribute to the total heat load.

The American Conference of Governmental Industrial Hygienists has issued a heat stress standard. This standard considers such factors as temperature (WBGT), workload, rest periods, water and salt supplementation, clothing, acclimation, and physical fitness.

The figure below summarizes the proposed ACGIH Heat Standard (1973). This is the recommended standard of the Massachusetts Department of Labor and Industries.



PREVENTIVE MEASURES A process evolving considerable heat should be segregated wherever practical. Equipment radiating at high temperatures should be well insulated or the worker should be protected by reflective shielding. Processes giving off steam should be enclosed and exhausted to minimize increases in temperature and humidity. General ventilation of the hot areas should be provided. In some instances cooling of the supply air by spray washers is necessary. Increasing air movement past workers by means of circulating fans will reduce the effective temperature at the work station.

Where air (dry bulb) temperatures exceed 150° F. or at lower temperatures where humidities approach 100%, protective clothing and equipment should be provided and used for extended work periods. Under extreme heat conditions, it is preferable to allow the worker to set his own work schedule even when special protective clothing is worn. When air temperatures at industrial processes exceed 250° F., it is essential to protect the eyes and the upper respiratory tract. Hand protection should be provided and used where temperatures exceed 130° F.

Rest periods, preferably in an air-conditioned room, should be taken before excessive fatigue develops and should be long enough to drop the heart beat rate to 100 beats per minute. (Reference: "Heating and Cooling for Man in Industry," published by the American Industrial Hygiene Association, 1970.) Salt replacement should be provided and encouraged if much water is used alone to replace sweat loss.

MEDICAL CONTROL The best medical control is prevention. It should be remembered that the major predisposing factor to heat sickness is inadequate salt intake. Workers with a chronic disease severe enough to produce symptoms should not be allowed to work in high temperatures.

If any worker begins to have any of the symptoms mentioned above, a physician should be summoned immediately or the patient transferred to a medical facility because an apparently mild case may suddenly or within a few hours change to a desperate one, with an alarming rise in body temperature. While awaiting the doctor, one should provide for those suffering from heat cramps or heat exhaustion, i.e., complete bed rest in a cool environment with good air circulation and with clothes removed. If body temperature is above 130° F. (39.5° C.), ice water bath is indicated. This should be continued until the temperature is below 103° F. Saline can be given intravenously if the person is not in cardiac failure. Salt given orally is useful only with heat cramps.

The worker who has suffered from the effects of heat should never be allowed to return to work the same day and should be examined by a physician before he does return to work. It is believed that persons suffering an attack of heat stroke have increased susceptibility to subsequent attacks and should not return to work when heat stroke is possible.

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No. 1207 Supersedes No. 1105 December, 1979

INCREASED PRESSURE

GENERAL In certain types of construction work, such as the building of submerged or underground tunnels and bridges or the laying of deep foundations for high rise buildings, it is often necessary that the work is performed with increased air pressure in order to prevent the water, sand and mud from entering the excavation. When a diver descends in deep water, his diving suit must be inflated to sufficient pressure to counteract the water pressure against his body. Also, scuba divers obtain air from a self-contained underwater breathing apparatus.

HAZARDS The hazards encountered in the specialized operations are the physiological effects of increased atmospheric pressure on the body. Most of the effects fall into two categories: those that are direct and mechanical and those that come about because of changes in partial pressure of the gases breathed.

1. DIRECTS EFFECTS OF PRESSURE These result from changes in air volume which accompany changes in air pressure during ascent or descent. The human body has air-filled spaces, such as the middle ear, the sinuses, and lungs. When pressure in these air spaces is different than ambient pressure, injury can occur.

A. MIDDLE EAR SQUEEZE The most common injury occurring during descent when pressure is increasing is middle ear squeeze. In this instance pressure in the middle ear is less than the pressure surrounding the man. The result is that fluid and blood seep into the middle ear space, and sometimes rupture of the eardrum occurs.

B. LUNG RUPTURE AND AIR EMBOLISM On ascent the ears and sinuses generally vent the expanding gas without difficulty. If the compressed air worker either holds his breath or is unable to adequately vent his lungs, then his lungs may rupture. When lung rupture occurs the expanding gas may escape into the chest cavity and cause a pneumothorax or may feed a stream of bubbles into the blood stream. These bubbles are then transported to the brain where they block the brain's blood supply. This is called an air embolism.

2. INDIRECT EFFECTS Some important hazards of compressed air work result from the increased partial pressures of the gases in the compressed air workers' breathing mixtures. At sea level where the total pressure is 1 atmosphere, the partial pressure of oxygen is about 0.2 atmosphere, and that of nitrogen is about 0.8 atmosphere. At 132 feet the total pressure is increased to 5 atmospheres and the partial pressure of oxygen is 1 atmosphere. Therefore breathing air at 132 feet is the equivalent of breathing pure oxygen at the surface.

A. OXYGEN POISONING Increased partial pressures of oxygen can be poisonous to a number of the body's organs, the most important of which are the brain and the lungs. If the partial pressure of oxygen which a man breathes is greater than two to three atmospheres, the increased concentration can be poisonous.

B. NITROGEN NARCOSIS Increased partial pressures of nitrogen can affect the brain and induce an anesthetic effect. The higher the partial pressure of nitrogen the more pronounced is this effect. The result can be impaired judgment resulting in fatal errors.

C. DECOMPRESSION SICKNESS (BENDS) As the compressed air worker is exposed to the increased pressure of depth, both nitrogen and oxygen go into solution in his blood and tissues. The deeper one dives or the longer one stays at a given depth, the more dissolved gas will be present. Eventually more dissolved gas will be present than can be kept dissolved at lower pressures. On ascent the excess of nitrogen will form bubbles. These bubbles can produce injury by blocking the blood supply to the tissues and by distending the tissues.

D. ASEPTIC BONE NECROSIS A late form of decompression sickness is aseptic bone necrosis, which is a result of inadequate decompression. There is death of bone, most commonly in the hip, knee and shoulder. Severe arthritis can be the consequence.

SIGNS AND SYMPTOMS

1. MIDDLE EAR SQUEEZE Severe ear ache, ringing in the ears, impaired hearing, dizziness and loss of equilibrium.

2. LUNG RUPTURE AND AIR EMBOLISM Severe chest pain and some difficulty in breathing can be associated with pneumothorax. Air embolism to the brain may result in unconsciousness, convulsions, paralysis and even death.

3. OXYGEN POISONING Warning signs of nervous system oxygen poisoning are nausea, dizziness and muscular twitching. If the exposure continues, convulsions may occur.

4. NITROGEN NARCOSIS Sensations similar to drunkenness with confusion and impaired judgment are produced in nitrogen narcosis.

5. DECOMPRESSION SICKNESS The seriousness of the bends depends primarily upon where the bubble occurs. Symptoms may appear at the time of ascent or within 24 to 48 hours after surfacing. The most common form of decompression sickness is localized pain, usually in the hips, knees, shoulder or elbows. This form of decompression sickness is commonly known as the "bends." Sometimes the nervous system is involved with symptoms of dizziness, paralysis, visual disturbances, convulsions and coma. Occasionally the lungs are involved when the lung circulation becomes filled with bubbles. In this instance there is chest pain and severe shortness of breath. Death may occur with any of the more severe forms of decompression sickness.

PREVENTION

1. OXYGEN POISONING Careful attention to air mixtures at specific depths allows for prevention.

2. NITROGEN NARCOSIS Narcosis is prevented by avoiding excessive depths when air is the breathing medium. At great depths helium is commonly used to substitute for nitrogen.

3. DECOMPRESSION SICKNESS Prevention of decompression sickness is best accomplished by carefully following established decompression schedules. Decompression schedules for caisson and tunneling work are given in the Federal Register, Vol. 37, No. 243, Part II. The decompression tables are computed for working chamber pressures from zero to 14 pounds per square inch gauge, and from 14 to 50 pounds per square inch gauge inclusive by 2 pound increments and for exposure times for each pressure extending from ½ to over 8 hours inclusive. Decompressions will be conducted by two stages with a maximum of four stages, the latter for a working chamber pressure of 40 pounds per square inch or over.

When working in compressed air in construction work, reference is made to Industrial Bulletin No. 7, "Rules and Regulations for the Prevention of Accidents in Tunnels, Shafts, Subways and Work Under Compressed Air," promulgated by the Department of Labor and Industries.

The U.S. Navy Diving Manual, December, 1975, 700 pages, GPO No. 008-046-000-86-7, provides reasonable decompression schedules for divers.

MEDICAL CONTROL

1. MIDDLE EAR SQUEEZE Treatment is as indicated for collection of any fluid in the middle ear or for ruptured ear drums.

2. LUNG RUPTURE AND AIR EMBOLISM Treatment is immediate recompression and, if pneumothorax is present, a drain must be placed to prevent tension pneumothorax.

3. OXYGEN POISONING Immediate administration of breathing mixture with low oxygen concentration results in rapid disappearance of convulsions and the attendant symptoms.

4. NITROGEN NARCOSIS Symptoms will disappear with ascent.

5. DECOMPRESSION SICKNESS The only effective treatment is immediate recompression with subsequent scheduled decompression.

All workers applying for work to be carried out under increased atmospheric pressure should be given thorough pre-employment physical examinations and selection made of only those between 20 and 40 years of age and free from pulmonary, cardiovascular, peripheral vascular, renal, or gastrointestinal disease and obesity. Any worker who shows symptoms of decompression sickness after one or two trial tests should be rejected. Annual physical examinations should be carried out on all workers so employed.

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No. 1276 Supersedes No. 1050 February, 1980

DAMPNESS

GENERAL There are many occupations in which a worker is exposed to operations which expose him to more or less constant moisture in the air. Such exposures are commonly found in the fish industries, tanneries, packing houses, artificial ice plants, construction work, plating shops, machinery factories where wet grinding is done, automobile wash stations, and paper and synthetic-textile mills. Bartenders, fruit and vegetable canners, dish washers, laundry workers, bottlers, hairdressers, cooks and washermen and -women may have their hands in water for several hours.

HAZARDS Rheumatic or neuralgic complaints may occur or be aggravated by such exposures to constant wetness. Although it is doubtful that dampness itself is responsible for respiratory infections, it may be a contributing factor. The skin of those workers exposed to a constant wetting operation may become dry, irritated and cracked, with fissure formation. Such workers may also develop fungus infections at the finger webs and inflammatory lesions about the nails.

PREVENTION When dampness is a feature of any industrial process, work places should be supplied with drain channels to prevent the accumulation of water and, in addition, duck boarding should be utilized wherever possible. Adequate waterproof clothing, such as rubber boots with nonskid soles, gloves, aprons, and trousers, should be supplied to the workers, depending on the type of operation.

It is important that workers wear dry clothing when they leave the place of work, especially during the wintertime.

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COBALT 60

HAZARD CLASSIFICATION HIGHLY HAZARDOUS DUE TO RADIOACTIVITY

GENERAL Cobalt metal or metallic alloy in rod, wire, tube or placque form is made radioactive in nuclear reactors. Cobalt 60 is sold under special U.S. Nuclear Regulatory Commission (NRC) authorization as the metal, metallic alloy (unplated with gold or other coating), or as a dissolved chloride. An authorized purchaser may request the NRC to make any cobalt compound intened for special use by the purchaser into radioactive cobalt. Radioactive cobalt 60 is being used by industry in radiography; as a calibration source of detector instruments; and for the locating of underground cables, or locating jammed pneumatic tube carriers. It is being used in medicine manily for the treatment of cancer and in research by industry and the sciences.

Cobalt 60 has a half-life of 5.3 years, disintegrating spontaneously through the emission of a beta particle t0.31 MEV), followed in cascade by two gamma photons (1.33 + 1.17 MEV), and resulting in essentially mono-energetic radiation.

HAZARD External. Durmg spontaneous disintegration, cobalt emits photons above one million electron volts, as well as relatively weak beta particles. While the beta particles may cause little trouble unless the cobalt 60 is in close proximity, the gamma photons which are similar in their action to powerful X-ray may, after penetrating the body tissue, collide with atoms in the body structure and cause injury if overexposure occurs.

Internal. Cobalt 60 may enter the body by ingestion, inhalation or through the broken skin. If excessive amounts of cobalt 60 gain access to the body, the beta and gamma radiation may cause serious damage within the body. Cobalt 60 tends to accumulate in the liver and possibly the spleen and kidneys. Elimination from the critical organs is difficult.

MAXIMUM PERMISSIBLE DOSE

Whole Body Gonads, lens of eye Head and trunk Active blood-forming organs	1.25 rems in any calendar quarter
All organs, including thyroid, other than those above	5.0 rems in any calendar quarter
Skin of whole body Thyroid	7.5 rems in any calendar quarter
Hands and forearms Feet and ankles	18.75 rems in any calendar quarter

Exposure of the Fetus of Fertile Women

During the entire gestation period, the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother shall not exceed 0.5 rem.

MAXIMUM PERMISSIBLE CONCENTRATION

Soluble - 0.3 microcurie of cobalt 60 per cubic meter of air.

Insoluble - 0.009 microcurie of cobalt 60 per cubic meter of air.

HARMFUL EFFECTS Local. If cobalt 60 is introduced through the skin in other than insignificant amounts, an area of local inflammation and possibly sterile abscesses may result. The skin on bombardment over a long period of time may become dry and inelastic and nails striated and brittle. Skin cancers may develop many years after a severe exposure at the site of the exposed tissue. Excessive radiation to the reproductive organs may cause temporary or permanent sterility. Excessive radiation directed to the uterus of a pregnant woman may cause injury and defective changes in the fetus.

Systemic. Excessive exposures may cause blood dyscrasia, bone destruction or cancers, and damage to the liver, kidneys and spleen.

PROTECTIVE MEASURES A. Reducing the time of exposure or concentration reduces the dosage proportionately.

B. Increasing the distance between operator and the cobalt 60 source decreases the dosage inversely as the square of the distance.

C. Shielding should be of such thickness as to reduce the dose to the gamma rays below the maximum permissible dose.

D. Labels should be affixed to the source or its container, indicating date of receipt, type and amount of activity, and shielded or unshielded danger range.

E. Remote control handling devices should be used to reduce exposure to the lowest practical value.

F. Operations which cause generation of dust and fumes of cobalt 60 should be ventilated to prevent inhalation by the workers and other plant personnel; otherwise suitable respiratory protective devices should be used.

G. Employees who may be exposed to measurable amounts of radiation should be monitored at intervals not exceeding one month, by the use of film badges.

H. If work with nonencapsulated cobalt 60 is done, the working areas should be checked frequently for contamination. Contamination should be removed as soon as possible.

I. During operations requiring a cobalt 60 source to be located outside of its shield (for example, radiography), the following precautions should be observed:

1. The area should be roped off at an appropriate distance from the source.
2. Radiation hazard signs should be posted near the source.
3. An attendant should be assigned to guard the area.

Relation between Distance and Millicurie-Hours for an Exposure of 100 Milliroentgens From an Unshielded Source.+

Millicurie-Hours	Distance to Source (Feet)
10	1.2
30	2.1
100	3.8
300	6.5
1,000	11.9
3,000	20.5
10,000	37.6

Protection Requirements for Cobalt ^{60} in Centimeters of Lead
To Reduce Radiation to 100 Mr. at a Specified Distance+

Millicurie-Hours	Thickness of Lead (Cm.) Required at a Distance of		
	1 ft.	3.2 ft.	6.5 ft.
100	5.0	0.7	0
300	7.0	2.8	0
1,000	9.1	4.9	2.5
3,000	11.0	6.8	4.4
10,000	13.1	8.9	6.5
30,000	15.0	10.8	8.4
100,000	17.2	12.9	10.5

Add 4.1 cm. lead to reduce radiation to 10 mr.

+ For more detailed information on shielding, refer to National Bureau of Standards Handbook 73, "Protection Against Radiations from Sealed Gamma Sources."

MEDICAL CONTROL Employees who work on a job with exposure to cobalt ^{60} within the approved limits of the Regulations are required to undergo a pre-employment physical examination, regular annual blood checks, and yearly physical examinations in case of a regular exposure to 25 per cent or more of the permissible dose of external radiation or 10 per cent of the maximum permissible amount of internal radiation. **(See Bulletin No. 1143)** Employees with a history of previous excessive radiation exposure, pregnant women, and minors under 18 years of age should not be accepted for this type of work.

In the event of accidental spillage or contamination, on the advice of an informed physician or a radiation safety officer, emergency treatment, including hospitalization if necessary, should be instituted at once.

REGISTRATION Unsealed sources of cobalt ^{60} in excess of 1 microcurie, or sealed sources in excess of 10 microcuries, and smaller unsealed sources totaling 10 microcuries or smaller sealed sources totaling 100 microcuries, used in industrial establishments in Massachusetts, must be registered with the Massachusetts Department of Labor and Industries, in accordance with its Industrial **Bulletin No. 5, "rules and Regulations.....Ionizing Radiation," dated December, 1978.**

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No. 1269 Supersedes No. 1163 November, 1979

STRONTIUM^{90}

HAZARD CLASSIFICATION - HIGHLY HAZARDOUS DUE TO RADIOACTIVITY.

GENERAL Strontium^{90} is a beta emitter and has a radioactive half-life of approximately 28 years. It decays spontaeously to yttrium^{90} which also is a beta emitter with a half-life of 64 hours. Approximately two weeks are required for radioactive equilibrium to be reached. Strontium^{90} is one of the major long-lived isotopes formed in nuclear fission.

Strontium^{90}, being a source of energetic beta rays, is used in thickness gauges, static dust elimination, calibration sources, batteries, and radiochemistry.

HAZARD External. Since strontium^{90} and its decay product, yttrium^{90}, emit 0.55 Mev. and 2.27 Mev. beta particles, respectively, external exposure can cause skin burns, manifested by itching, reddening and possibly ulceration of the skin, and loss of hair on the irradiated area. Secondary X-radiation (Bremsstrahlung) occurs when the beta particles strike various materials. This X-ray production is greater for denser materials.

Internal. Strontium^{90} is highly hazardous when inhaled or ingested because it is deposited in the trabecular system of the bone in close proximity to the radiosensitive bone marrow.

MAXIMUM PERMISSIBLE DOSE

External -

Whole Body Gonads, lens of eye Head and trunk Active blood-forming organs	1.25 rems in any calendar quarter
All organs, including thyroid, other than those above	5.0 rems in any calendar quarter
Skin of whole body Thyroid	7.5 rems in any calendar quarter
Hands and forearms Feet and ankles	18.75 rems in any calendar quarter

Internal - Total body burden - 2 microcuries

Exposure of the Fetus of Fertile Women

During the entire gestation period, the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother shall not exceed 0.5 rem.

MAXIMUM PERMISSIBLE CONCENTRATION Atmospheric - 1×10^{-3} microcuries per cubic meter of air.

For soluble component, the limits based on values contained in Title 10, Appendix B, of the Code of Federal Regulation, Part 20 are:

	Unrestricted Areas	Restricted Areas
In Air	3×10^{-11} µCi /cc	1×10^{-9} µCi/cc
In Water	3×10^{-7} µCi /cc	1×10^{-5} µCi/cc

*Limits are based on values contained in 10 CFR 20, App. B.

PROTECTIVE MEASURES The radiation dosage should be kept as low as possible at all times. Provision should be made for adequate shielding, protective clothing, and remote control handling devices. Operations which produce dust should be done in an approved ventilated hood or a "dry box" and suitable respiratory protective devices worn.

Shielding should be of plastic or similar material, since the denser materials (heavy metals) when struck by beta particles emit more X-radiation (Bremsstrahlung).

The window for the strontium^{90} source used in a gauge is extremely fragile (approximately 0.001 in.). The gauge should be handled with sufficient precaution to preclude puncture of the source window. The radiation shield for the gauge should be kept in place except when the gauge is in use.

Dosimeters or film badges should be worn by exposed employees. Urinalyses for strontium^{90} should be made routinely on all employees working with unsealed strontium^{90} sources in significant amounts. A urinary excretion rate of 100 dpm. per liter (4.5×10^{-6} µCi per liter) indicates a need for a more stringent control program. Area monitoring, such as air tests and wipe tests, should be performed periodically and records of such tests kept by the employer.

MEDICAL CONTROL General - Employees exposed to radioactive material are subject to regulations which require the keeping of medical records, pre-employment examinations with special emphasis upon previous exposures, skin, eyes and lymphatic tissues, blood counts, and close medical follow up. (See Bulletin No. 1143, "Medical Examination of Personnel Exposed to Ionizing Radiation.") In case of overexposure, immediate medical attention with prolonged medical supervision and temporary removal from further exposure are indicated.

Specific - Strontium^{90} is mainly deposited in bones similarly to radium. Once internal exposure has occurred, the sequellae are dependent on the length of exposure, dosage and part of the body affected and may require prolonged medical supervision and follow up.

REGISTRATION Unsealed sources of strontium^{90} in excess of 0.1 microcurie or sealed sources in excess of 1 microcurie, and smaller unsealed sources totaling 1 microcurie or more, and smaller sealed sources totaling 10 microcuries or more, (except when used in exempted devices) when used in industrial establishments must be registered with the Massachusetts Department of Labor and Industries, in accordance with its Industrial Bulletin No. 5, "Rules and Regulations. . . . . Ionizing Radiation," dated December, 1978.

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No. 1306 Supersedes No. 1166 April, 1982

TRITIUM

HAZARD CLASSIFICATION Tritium gas is only slightly hazardous. Tritiated water (HTO) is moderately hazardous due to its radioactivity.

GENERAL Tritium (^3H), the only radioactive isotope of hydrogen, emits an 0.0186 Mev. (million electron volts) beta particle and decays to helium with half-life of 12.46 years. Pure tritiated water has an activity of 2,700 curies per gram. However, partially tritiated water is commonly available at activities up to 1 curie per gram. Tritium may be used in luminous paints, in chemical and biological research, in the production of tagged chemical compounds, and in controlled fusion experiments.

HAZARD Tritium emits a very low energy beta particle and for this reason presents little radiation hazard externally. Even on inhalation hardly any ^3H gas is retained, and only the lungs are exposed to beta radiation. However, tritiated water (HTO) is much more hazardous because on inhalation it is rapidly and evenly distributed throughout the body. It can also be readily absorbed through the skin.

MAXIMUM PERMISSIBLE CONCENTRATION Total body burden - 1.0×10^3 microcuries

	Unrestricted Areas	Restricted Areas
In Air	2×10^{-7} μ Ci/ml	5×10^{-6} μ Ci/ml
In Water	3×10^{-3} μ Ci/ml	1×10^{-1} μ Ci/ml

PROTECTIVE MEASURES All operations in which tritium is used should be carried on in a well-ventilated booth or in an enclosed system. Workers should be required to wear protective clothing, such as rubber gloves and laboratory smocks, when handling tritiated water in order to minimize skin absorption. Air monitoring of work area should be done where potentially hazardous amounts of tritium are used.

MEDICAL CONTROL General - Employees exposed to radioactive material are subject to regulations which require the keeping of medical records, pre-employment examinations with special emphasis upon previous exposures, skin, eyes and lymphatic tissues, blood counts, yearly checkups and final examination upon termination of exposure. (See Bulletin No. 1143.) In case of overexposure, immediate medical attention, close follow up for a prolonged period of time, and temporary removal from further exposure are indicated.

Specific - Urine specimens from exposed workers should be analyzed routinely for tritium content when substantial amounts (one or more curies) are being used, and complete records of such tests should be kept. The recommended tolerance is 28 microcuries of tritium per liter of urine.

REGISTRATION Sources of tritium (sealed or unsealed) in excess of 1,000 microcuries, and smaller number of sources exceeding 10 and totaling 10,000 microcuries or more, used in industrial establishments, must be registered with the Massachusetts Department of Labor and Industries, in accordance with Rule 4 of Industrial Bulletin No. 5, "Rules and Regulations.....Ionizing Radiation" effective December 15, 1978.

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KRYPTON ^{85}

HAZARD CLASSIFICATION Slightly hazardous due to radioactivity.

GENERAL Krypton^{85} is a radioactive gas which may be purchased under U.S. Atomic Energy Commission license. It is shipped in metal cylinders either pure or mixed with an inert nonradioactive gas, such as argon. Krypton^{85} occurs as a fission product of uranium or may be prepared by bombarding nonradioactive krypton with neutrons in a reactor.

Krypton^{85} is presently being used as a cathode activator in electronic tube manufacture, as a tracer element for detecting leaks, a phosphor coating activator, in clathrates and in thickness gauges. It has been used medically to study the mechanism of inert gas exchange in the human body.

Krypton^{85} has a half-life of approximately ten years, disintegrating spontaneously through the emission of a beta particle (99+%), having a energy of 0.695 million electron volts, and a second beta particle (0.65%), having an energy of 0.15 million electron volts. A gamma photon of 0.54 million electron volts occurs coincidentally with the 0.15 Mev. beta particle. Krypton^{85} is thus primarily a beta emitter. However, the emission of gamma photon and bremsstrahlung (similar to X-rays) is very significant in large sources.

HAZARD Krypton^{85}, being a gas, is usually confined to a cylinder or other closed container. The intensity of the ionizing radiation emitted through the containers is dependent upon the activity of the gas present, thickness of the container, and the method of use. Krypton is an inert gas and will not be retained to any great extent in the lungs nor react with other gases inhaled; however, it may be absorbed reversibly in the body fluids and hence penetrate into the deeper tissue areas. The hazard may be due primarily to the exposure of the internal body tissues to beta radiation.

MAXIMUM PERMISSIBLE DOSE

Gonads, lens of eye Head and trunk Active blood-forming organs	1.25 rems in any calendar quarter
All organs, including thyroid, other than those above	5.0 rems in any calendar quarter
Skin of whole body Thyroid	7.5 rems in any calendar quarter
Hands and forearms Feet and ankles	18.75 rems in any calendar quarter

Exposure of the Fetus of Fertile Women

During the entire gestation period, the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother shall not exceed 0.5 rem.

MAXIMUM PERMISSIBLE CONCENTRATION Atmospheric - 10 microcuries of krypton^{85} per cubic meter of air.

PROTECTIVE MEASURES This gas should be stored in leak-proof gas cylinders or other containers constructed to withstand the gas pressure. Precautions should be taken to avoid inhalation of krypton^{85}. Operations in which this gas is used should be properly ventilated to the outdoors, and containers and apparatus holding the bulk supply of krypton^{85} should bear warning labels.

MEDICAL CONTROL Employees exposed to radioactive krypton are subject to regulations which require the keeping of medical records, pre-employment physical examinations with special emphasis upon previous exposures, skin, eyes and lymphatic tissues, complete blood counts, yearly check ups and, where feasible, final examination upon termination of exposure. (See Bulletin No. 1143). In case of overexposure, immediate medical attention, close follow-up for prolonged period of time, and temporary removal from further exposure are indicated.

REGISTRATION Sealed or unsealed sources of krypton^{85} exceeding 100 microcuries and smaller sources totaling 1,000 microcuries or more, used in industrial establishments, must be registered with the Massachusetts Department of Labor and Industries, in accordance with its Industrial Bulletin No. 5, "Rules and Regulations.....Ionizing Radiation," dated December 15, 1978.

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No. 1264 Supersedes No. 1172 October, 1979

IRIDIUM ^{192}

HAZARD CLASSIFICATION HIGHLY HAZARDOUS DUE TO RADIOACTIVITY

GENERAL Iridium metal in various shapes and sizes, depending upon need, is made radioactive in nuclear reactors. Radioactive iridium is being used extensively by industry in radiography. It is also used for a calibration source. In medicine, Iridium ^{192} has been used as a teletherapy source and as an inexpensive substitute for radium in the irradiation treatment of some types of cancer.

Iridium ^{192} has a half-life of 74.5 days, disintegrating spontaneously through the emission of a beta particle of 0.67 Mev. and up to 20 gamma photons of 0.136 to 0.612 Mev. Iridium ^{192} as a sealed source is used in industrial radiography primarily for its gamma ray penetrating power.

HAZARD External - While the beta particles may cause little damage unless the Iridium ^{192} is in close proximity, the gamma photons which are similar in their action to powerful X-rays may, after penetrating into the body tissue, collide with atoms in the body structure and cause injury if overexposure occurs.

Internal - Although incidents involving inhalation of Iridium ^{192} powder have occurred, it is used in industry chiefly as a sealed source so that ordinarily there is little likelihood of inhalation of dust from this radioactive material.

MAXIMUM PERMISSIBLE DOSE

Whole Body Gonads, lens of eye Head and trunk Active blood-forming organs	1.25 rems in any calendar quarter
All organs, including thyroid, other than those above	5.0 rems in any calendar quarter
Skin of whole body Thyroid	7.5 rems in any calendar quarter
Hands and forearms Feet and ankles	18.75 rems in any calendar quarter

Exposure of the Fetus of Fertile Women

During the entire gestation period, the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother shall not exceed 0.5 rem.

MAXIMUM PERMISSIBLE CONCENTRATION Atmospheric-0.03 microcuries of Iridium ^{192} (insoluble) per cubic meter of air

HARMFUL EFFECTS Local - The skin on exposure over a long period of time to the ionizing radiation emitted by Iridium ^{192} will become dry and inelastic and the nails striated and brittle. Skin cancer may develop many years after a severe localized exposure. Excessive radiation to the reproductive organs may cause temporary or permanent sterility. Excessive radiation to the uterus of a pregnant woman may cause injury and defective changes in the fetus.

Systemic - Excessive exposures may cause blood dyscrasia, bone destruction or cancer, and damage to certain organs within the body.

PROTECTIVE MEASURES The following precautions are applicable to any source of gamma radiation.

A. Reducing the time of exposure or activity reduces the dosage proportionately

B. Increasing the distance between the operator and the source decreases the dosage as the square of the distance.

The following table shows the relationship between distance and millicuries for an exposure of 100 mr. from an unshielded source of Ir^{192}:

Table 1

Relation Between Distance and Millicurie-Hours

Millicurie-Hours	Distance to Source (Feet)
10	0.7
30	1.3
100	2.3
300	4.0
1,000	7.4
3,000	12.7
10,000	23.2

C. Shielding should be of such thickness as to reduce the exposure to gamma rays to below the maximum permissible dose. The thickness of lead shielding required to reduce the ionizing radiation to 100 mr. at a specified distance is contained in Table 2.

Table 2

Protection Requirements for Iridium ^{192} *

Millicurie-Hours	Thickness of Lead (Cm.) Required at a Distance of		
	1 ft.	3.2 ft.	6.5 ft.
100	0.8	0	0
300	1.4	0.1	0
1.000	2.2	0.7	0.1
3.000	3.1	1.4	0.6
10.000	4.0	2.1	1.2
30.000	5.0	3.0	2.0
100.000	6.2	4.0	2.8

*For more detailed information on shielding, refer to National Bureau of Standards Handbook 73, "Protection Against Radiations from Sealed Gamma Sources."

Note: Add 2.0 cm. lead to reduce radiation to 10 mr.

D. Labels should be affixed to the source or container, indicating date of receipt, type and amount of activity.

E. Remote control or sufficiently long handling devices should be used to reduce personnel exposure to the lowest practical value.

F. Personnel monitoring by devices should be used to evaluate exposure.

G. During operations requiring an Iridium^{192} source to be located outside of its shield, as in radiography, the following precautions should be observed:

1. The area should be roped off at an appropriate distance from the source.
2. Radiation warning signs should be posted near the source.
3. An attendant should be assigned to guard the area.
4. The area should be monitored by an appropriate survey instrument.

MEDICAL CONTROL General - Employees exposed to radioactive material are subject to regulations which require the keeping of medical records, pre-employment examinations with special emphasis upon previous exposures, skin, eyes and lymphatic tissues, blood counts, yearly physical check ups and final examination upon termination of exposure. (See Bulletin No. 1143.) In case of overexposure immediate medical attention, close follow-up for a prolonged period of time and temporary removal from further exposure are indicated.

Specific - Radioactive iridium is essentially a gamma emitter, and if overexposure occurs, its effects are similar to those observed in radium overexposure, that is, local damage to skin, mucous membranes and nails, as well as damage to eyes, reproductive organs and internal organs, such as the lungs.

REGISTRATION **Unsealed sources of Iridium^{192} in excess of 10 microcuries and sealed sources in excess of 50 microcuries used in industrial establishments, must be registered with the Massachusetts Department of Labor and Industries, in accordance with its Industrial Bulletin No. 5, "Rules and Regulations..... Ionizing Radiation," effective December 15, 1978. Possession, use or storage of ten (10) or more sources below the exempt limits are also required to be registered.**

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No. 1273 Supersedes No. 1133 April, 1983

T H O R I U M

HAZARD CLASSIFICATION MODERATELY HAZARDOUS DUE TO RADIOACTIVITY

GENERAL There are 13 isotopes of thorium. Four of these isotopes-- Th^{232}, Th^{228} (radiothorium), Th^{234} (uranium X_1), and Th^{230} (Ionium)--have industrial importance as health hazards. Of these, Th^{232} and Th^{228} occur in thorium minerals, and Th^{234} and Th^{230}, are found in natural uranium. Two other thorium isotopes, Th^{231} and Th^{227}, are present in uranium minerals as members of the U^{235} decay chain. The remaining thorium isotopes are either produced directly by neutron bombardment of precursor isotopes or are found in artificially-produced isotopic decay chains.

Thoron, one of the daughter products, is a radioactive gas with a half-life of 55 seconds. It decays to radioactive solid particles which lodge on atmospheric dust and cause contamination of the air.

Thorium is used in the manufacture of gas mantles, fuel elements for atomic reactors, refractory material, high accuracy optical glass, as a chemical catalyst, and as a coating for tungsten filaments and welding electrodes. Thorium-magnesium alloy, containing up to 4% thorium, is used for jet engine castings, supersonic air-frame constructions, and satellite rockets.

HAZARD External - The external radiation hazard is due primarily to gamma activity from the parent material and decay products.

Internal - Insoluble forms of thorium lodge in the lungs, while the more soluble forms enter the blood stream and are deposited in or near the bones.

MAXIMUM PERMISSIBLE DOSE*

External

Whole body Gonads, lens of eye Head and trunk Active blood-forming organs	1.25 rems in any calendar quarter
All organs, including thyroid, other than those above	5.0 rems in any calendar quarter
Skin of whole body Thyroid	7.5 rems in any calendar quarter
Hands and forearms Feet and ankles	18.75 rems in any calendar quarter

*Exposure of the Fetus of Fertile Women

During the entire gestation period, the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother shall not exceed 0.5 rem.

Internal - Total body burden
Thorium (Soluble) - 0.3 microcurie

MAXIMUM PERMISSIBLE DOSE — Atmospheric - Thorium - 3×10^{-5} microcuries per cubic meter of air.

Thoron - 0.3 microcurie per cubic meter of air.

HARMFUL EFFECTS Thorium may cause lung damage if inhaled and damage to liver, spleen and bones if taken internally in excessive amounts. If the skin is affected, there is damage of skin cancer.

PROTECTIVE MEASURES Persons working with thorium are required to wear a film badge if the expected exposure exceeds 25 per cent of the maximum permissible external dose. If dusty operations are performed, adequate local exhaust ventilation should be provided and, if necessary, ultra-filter dust respirators worn. In order to minimize hand contact, gloves should be worn whenever possible.

The approximate time per calendar quarter for handling the metal to produce a quarterly maximum permissible exposure of 18.75 rems to the hands is 125 hours, or with 1 millimeter thick leather gloves, 250 hours.

Thorium should be stored and processed in well-ventilated areas. Approximately 300 square inches of thorium metal surface per cubic foot of room volume produces a maximum permissible concentration of thoron for continuous exposure. Chips, shavings, and finely divided metallic thorium, as well as thorium oxide powder, are efficient generators of thoron and should be stored in well-ventilated areas. Closed containers should be used for storage, and such containers should be opened in a well-ventilated hood whenever possible.

MEDICAL CONTROL General - Employees exposed to radioactive material are subject to regulations which require the keeping of medical records, pre-employment physical examination with special emphasis upon previous exposures, skin, eyes and lymphatic tissues, blood counts, an annual examination, and a final examination upon termination of exposure. (See Bulletin No. 1143) In case of overexposure, immediate medical attention, close follow up for a prolonged period of time, and temporary removal from further exposure are indicated.

Specific - Once thorium enters the body, it will remain fixed for a long time and thus exert effects similar to those found after overexposure to radium. The use of thorium in medicine has shown that it is stored primarily in the spleen, liver and bones and may cause later damage in the form of cancer or leukemia.

REGISTRATION Sources of sealed or unsealed thorium exceeding 500 microcuries (about 4.97 lbs.) and smaller sources totaling 5,000 microcuries or more (about 49.7 lbs.), used in industrial establishments, are required to be registered with the Massachusetts Department of Labor and Industries, in accordance with its Industrial Bulletin No. 5, "Rules and Regulations..... ...Ionizing Radiation," dated December, 1978.

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RADIUM

HAZARD CLASSIFICATION *EXTREMELY HAZARDOUS DUE TO RADIOACTIVITY*

GENERAL Radium^{226} is a naturally-occurring radioactive metal found in all ores of uranium from which it originates during the process of disintegration in the proportion of about 3,400,000 parts of uranium to one part of radium. Radium can be prepared in the metallic form, but except when plated on an inert metal, usually is available commercially in the form of a salt, such as the sulfate, bromide, chloride, or carbonate. The dehydrated salts of radium may be encapsulated usually in base metals when used industrially and in noble metals for medical use. Radium is being employed by industry in radiography, in electrostatic eliminators, as an ingredient in self-luminous paints, in some low vacuum gauges, as an activator in electronic tube manufacture, in detector devices, in neutron sources, and as a calibration source.

Radium has a half-life of approximately 1,600 years, disintegrating spontaneously into the radioactive gas, radon, which, in turn, disintegrates in eight major additional steps, the end-product being stable lead^{206}. Alpha, beta and gamma rays are given off.

The alpha particles from radium plus its daughters have an effective total energy of 24 million electron volts. The energies from the individual isotopes vary from 0.007 Mev. gamma radiation for Radium D (Pb^{210}) to 10.5 Mev. alpha radiation for Radium C (Po^{214}).

HAZARD External. The chief external hazard from radium is due to gamma radiation. Relatively hard gamma rays are given off by some of the members of the radium series. Such rays may, after penetrating the body tissues, collide with atoms in the body structure and cause injury if overexposure occurs. Beta particles which are also given off are usually absorbed in the first 1 mm. depth of skin and may cause damage to that tissue.

Internal. Radium and its daughter products may enter the body by ingestion, inhalation, or through the broken skin. If excessive amounts gain access to the body, the alpha, beta, and gamma radiation may cause serious damage to the body. The alpha particles due to their ionizing ability may cause the greatest injury when within the body. Radium tends to collect in the bony structure of the body, particularly in the long bones. Elimination from the critical organ (bones) is difficult. In addition, unsealed radium sources give off radon gas.

MAXIMUM PERMISSIBLE DOSE

External -

Gonads, lens of eye Head and trunk Active blood-forming organs	1.25 rems in any calendar quarter
All organs, including thyroid, other than those above	5.0 rems in any calendar quarter
Skin of whole body Thyroid	7.5 rems in any calendar quarter
Hands and forearms Feet and ankles	18.75 rems in any calendar quarter

Internal - Maximum permissible amount in total body - 0.2 microcurie.

Exposure of the Fetus of Fertile Women

During the entire gestation period, the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother shall not exceed 0.5 rem.

MAXIMUM PERMISSIBLE CONCENTRATION (MPC)

	Unrestricted Areas	Restricted Areas
In Air	3×10^{-12} μCi/cc	3×10^{-11} μCi/cc
In Water	3×10^{-8} μCi/cc	4×10^{-7} μCi/cc

HARMFUL EFFECTS Local. Radium in contact with the intact skin surface may cause serious burns. If introduced through the broken skin in other than insignificant amounts, an area of local inflammation may result. Also, some radium will be carried by the blood stream and deposited in the body skeleton. The skin on overexposure during a long period of time will become dry and inelastic. Skin cancer may develop many years after a severe exposure to the localized tissue. Excess radiation to the reproductive organs may cause temporary or permanent sterility. Excess radiation directed to the uterus of a pregnant woman may cause injury and defective changes in the fetus.

Systemic. Excessive exposure may cause blood dyscrasia, accompanied by swelling and bleeding of the gums, enlargement of the spleen and lymph nodes, bleeding tendency, and bone destruction or cancer formation.

PROTECTIVE MEASURES A. Increasing the distance between the operator and the radium source decreases the dosage inversely as the square of the distance. The following table shows the relationship between distance and millicuries for an exposure of 100 mr. from an unshielded source of radium.

Table 1

Relation Between Distance and Millicurie-Hours

Millicurie-Hours	Distance to Source (Feet)
10	0.9
30	1.6
100	3.0
300	5.1
1,000	9.4
3,000	16.3
10,000	30.1

B. Shielding should be of such thickness as to reduce the exposure to the gamma rays to below the maximum permissible dose. The following table gives the shielding needed to reduce radiation to 100 mR/hr at the specified distances.

MEDICAL CONTROL General - Employees exposed to radioactive material are subject to regulations which require the keeping of medical records, pre-employment examinations with special emphasis upon previous exposures, skin, eyes and lymphatic tissues, blood counts, yearly check ups and final examination upon termination of exposure. (See Bulletin No. 1143.) In case of overexposure, immediate medical attention, close follow up for a prolonged period of time, and temporary removal from further exposure are indicated.

Specific - Since radium in external application causes dermatitis, ulceration, destruction of tissues with scar formation and danger of cancer, protection against external radiation is most important.

Once radium has entered internal organs, it tends to be deposited in the bone or, in case of inhalation, in the lungs. The involvement of these organs may lead to cancer or blood dyscrasias. In such cases intensive medical treatment is required.

The determination of radon in breath is presently the principal method of determining the amount of absorption of radium and the resultant body burden. The present maximum allowable radon content in the breath is 1 microcurie of radon per liter of air.

REGISTRATION Unsealed sources in excess of 0.1 microcurie, or sealed sources in excess of 1.0 microcurie, and smaller unsealed sources totaling 1 microcurie or more or smaller sealed sources totaling 10 microcuries or more, used in industrial establishments in Massachusetts, must be registered with the Massachusetts Departments of Labor and Industries, in accordance with its Industrial Bulletin No. 5, "Rules and Regulations.....Ionizing Radiation," dated December, 1978.

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Table 2

Protection Requirements for Radium*

Millicurie-Hours	Thickness of Lead in Centimeters Required to Reduce Radiation to 100 mR/hr at a Distance of:		
	1 ft.	3.2 ft.	6.5 ft.
100	4.0	0	0
300	6.2	1.5	0
1,000	8.9	3.6	1.1
3,000	11.3	5.8	3.1
10,000	14.1	8.5	5.5
30,000	16.7	11.0	7.8
100,000	19.5	13.7	10.5

Note: Add 5.5 cm lead to reduce radiation to 10 mR/hr.

*For more detailed information on shielding, refer to National Bureau of Standards Handbook 73, "Protection Against Radiations from Sealed Gamma Sources."

C. If work with nonencapsulated radium is performed, the working areas should be checked frequently for contamination. Contamination should be removed as soon as possible

D. Operations which cause generation of dust and fumes of radium should be ventilated to prevent inhalation by the workers or other plant personnel, otherwise suitable respiratory protective devices should be used.

E. Labels should be affixed to the source or its container, indicating date of receipt, type and amount of activity, and shielded or unshielded danger range. The source capsule should be engraved with a notation saying, "Radium - Radioactive."

F. Employees who may be exposed to measurable amounts of radiation should be monitored by the use of film badges at intervals not exceeding one month

G. A ventilation rate of 50 cubic feet of air per minute is required to dilute the radon gas given off by one milligram of unsealed radium to the maximum permissible concentration. Containers of unsealed radium sources should be opened in an exhaust ventilated hood.

H. The Division of Occupational Hygiene should be contacted for specific work rules for any operations involving the application of radium-base luminous paints.

LEAK TESTING OF SEALED RADIOACTIVE SOURCES

GENERAL A sealed source shall mean any radioactive material that is encased in and is to be used only in a permanent container in a manner intended to prevent leakage of the radioactive material and yet permitting the radioactive material to be used as a source of radiation.

There are many types and applications of sealed sources. The sources may range in radioactivity from a few microcuries to many kilocuries. The permanent container in which the radioactive material is sealed may be made of metal, plastic or any other materials. The seal may be affected by welding, soldering, heat-sealing or other means such that the container can accidentally open, break or spill the contents during normal handling of the source. The design and construction of the permanent container may vary with the intended use of the source.

A brief description of the more commonly used sources follows:

Radiographic sources most usually contain cobalt^{60}, iridium^{192} or radium^{226}. The gamma radiations from these sources are used to inspect welds, castings or components for internal defects.

Gauging sources most commonly contain krypton^{85}, strontium^{90} or cesium^{137}. The beta or gamma radiations from these sources are used for measuring thickness, density or liquid level.

Static eliminators ordinarily contain radium^{226}, polonium^{210}, or americium^{241}. The radiation ionizes the air in the vicinity of the source, providing a conducting path for removal of static electricity from the product.

HAZARD The safety problem in handling sealed sources will vary with the amount of radioactivity, the type of permanent container, the energy and the chemical form of the radioisotope, and the use of the source. Many of the sealed sources can and do present an external radiation hazard; but, as long as the sealed permanent container remains intact, they present no internal radiation hazard.

REQUIREMENTS In order to make certain that the sealed container is intact, periodic tests should be performed. These tests are commonly referred to as "leak tests."

Section 7.5 of Industrial Bulletin No. 5 states:

"Each liquid or solid sealed source shall be tested for leakage before being placed in use and thereafter shall be tested for leakage at intervals not to exceed six months, unless specifically exempted by the Commissioner. Any registered sealed source is exempt from such leak tests when the source contains 100 microcuries or less of beta and/or gamma emitting material, or 10 microcuries or less of alpha emitting material. If the sealed source is found to be leaking in an amount greater than 0.005 microcurie, the employer shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with Section 13.7."

Section 7.5 shall apply to all sealed sources with the following exceptions:

(1) Sealed sources containing only radioactive material having a half life of 30 days or less.
(2) Sealed sources containing only radioactive material in the form of a gas.
(3) Sealed sources specifically exempted by the Commissioner after demonstration by the manufacturer or user and study by the Commissioner of the construction, use and handling of the source have proved that the potential hazard is at an absolute minimum.
(4) Sealed sources that are exempt from the provisions of Industrial Bulletin No. 5 (Section 14.) and Appendix 1.
***(5) Sealed sources that are stored and are not being used.**

METHODS The leak test should be made by or under the direction of the Radiation Safety Officer or by other qualified persons.

The test sample shall be taken from the surface of the sealed source or from the appropriate accessible surface of the device in which the sealed sourced is permanently or semipermanently mounted or stored. Examples of accessible surfaces would be the interior of a source container; the interior of the positioning tube on a radiography device; the exterior of the source container on a gauge.

***Stored nongaseous sources, however, shall not be used or transferred unless leak tested within six months.**

The most common method of making a test is to wipe the sealed source or appropriate surface with a patch of filter paper or cloth swab. If the source is leaking, the contamination wiped off by the test sample may then be found on the patch or swab with radiation detection instruments.

A source is considered to be leaking significantly and shall be removed from service if the leak test discloses the presence of 0.005 microcurie or more of contamination. The curie is a unit of radioactivity equal to 37 billion disintegrations per second; therefore, 0.005 microcurie is approximately equal to 11,000 disintegrations per minute. This is a comparatively small amount of activity, and its detection requires the use of special instruments by a person who can correctly interpret the results given by the equipment.

The instrument to be used must be selected with regard to the type of radiation (alpha,beta or gamma) and the energy of the radiation (usually expressed in million electron volts). For example, an instrument used to detect gamma rays (e.g., cobalt^{60}) would not detect alpha particles (e.g., polonium^{210}), and an instrument to detect high energy beta particles (e.g., phosphorus^{32} 1.707 mev) would not detect low energy beta particles (e.g., hydrogen^{3} 0.018 mev.).

Instruments are usually read in counts per minute. This figure must be converted to disintegrations per minute by subtracting background and applying an efficiency factor that involves geometry of the instrument, scattering, etc. The number of disintegrations per minute must then be converted to curie units to compare with the maximum allowable amount of contamination on a sealed source (0.005 microcurie).

Instruments commonly used for this type of work include scintillation counters, internal gas proportional counters, and Geiger-Mueller counters.

When a leak test is made, great care must be taken by the person performing the test to make certain that neither he nor any other persons in the vicinity are unnecessarily exposed to external radiation. This is best accomplished by making use of the radiation protective guides--distance, shielding and/or time.

Other important safety practices which must be observed when leak tests are made are as follows:

(1) Beta sources in excess of 1 millicurie should be handled with tweezers behind plastic shielding.
(2) Care should be taken not to puncture any thin window on the source.
(3) Gamma sources of high intensity should be handled only behind heavy shielding and with remote handling tools.
(4) Leak tests of high intensity sources are normally made on accessible surfaces. A survey instrument should be used to assure that the source is in a shielded position.
(5) Alpha sources have a very thin covering and hence must be handled with great care.

It may be seen from the above that in order to make leak tests on sealed sources safely and to obtain meaningful results from these tests, the leak tests should be carried out by a thoroughly competent person.

Caution: It should be remembered that although 0.005 microcurie is accepted as the upper limit of permissible contamination, it may be presumed that a marked increase of radiation levels from one test to another indicates leakage of the sealed source and prompt action should be taken by the user to ensure that the source leakage is kept within permissible limits.

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MICROWAVES

HAZARD CLASSIFICATION Hazardous -May cause burns, cataracts, sterility and other biological effects

GENERAL Microwave radiation is non ionizing electromagnetic energy having a wavelength of approximately 3 meters to 1 millimeter, corresponding to frequencies of approximately 100 to 300,000 megahertz. These frequencies lie between conventional radio frequencies and the far infra-red portion of the electromagnetic spectrum. Microwave wavelengths are sufficiently short to exhibit some of the properties of light.

Microwave radiation is used in: cooking ovens, dryers, heaters, radar, TV transmission, communication and navigation devices, diathermy units, cauterizers, alarm systems and spectroscopy.

Industrial, Scientific and Medical equipment utilizing radio frequency radiation are allocated the following ISM frequencies and wavelengths by the Federal Communications Commission: 915 MHz±13 MHz (32.8cm); 2450 MHz±50 MHz (12.2 cm); 5800 MHz± 75 MHz (5.2 cm); 24125 MHz± 125 MHz (1.2 cm).

HARMFUL EFFECTS The human body is susceptible to microwave radiation in varying degrees and may reflect, absorb, or be transparent to the radiation, or react in any combination of these, depending on the wavelength. The degree of physical harm that may be produced depends on both the intensity of the radiation and the duration of the exposure.

At high doses, this radiation can cause cataracts, sterility, burns, etc. At lesser doses, it is reported that microwave radiation can result in non-thermal effects, such as changes in nerve **impulse propagation, but these effects have not been substantiated at this time.**

Damage to human tissue or organs is, based upon present knowledge, most likely to occur from the thermal (heating) effects of microwave radiation. The most absorbent tissues are those with a high water content such as skin, muscles or internal organs. Skin can efficiently dissipate heat by an increased flow of blood and can be cooled by evaporation of perspiration.

Evidence indicates that the eyes and gonads are the most vulnerable to microwave radiation. Because of its relatively poor blood supply, the lens of the eye does not have a cooling system to conduct away excessive heat, and it cannot repair itself, as occurs in reparative processes elsewhere in the body. Thus, damage to the lens of the eye is generally irreversible, and depending on the dose, the damaged cells slowly lose their transparency; opacity may not occur until some time after exposure. Microwaves have been shown to produce cataracts in man following accidental exposure. Microwave radiation may also produce damage to other ocular structures, such as the conjunctiva, cornea, and iris. The testicles are extremely sensitive to elevations in temperature and appear to be the most sensitive organs in terms of the minimum exposure to elevated temperature required to produce a minimal change.

In addition to microwave radiation itself, significant commonplace hazards are: injuries from contact with high voltage developed in parts of the microwave equipment and ionizing radiation from incidental X-rays produced by the high-power klystron, magnetron or thyratron tubes.

At times gases such as sulfur hexafluoride may be used in wave guides to increase the dielectric strength. Arcing through the gas could decompose it and release toxic fluorine gas.

PERMISSIBLE EXPOSURE A. Threshold Limit Values (American Conference of Governmental Industrial Hygienists) for occupational microwave energy exposure in the frequency range of 300 MHz to 300 GHz where power density or field intensity is known and exposure time is controlled are as follows:

*Recommended Values:

1. For exposure to continuous wave (CW) sources, the power density level shall not exceed 10 milliwatts per square centimeter (mW/cm^2) for continuous exposure, and the total exposure time shall be limited to an eight-hour work-

day. This power density is approximately equivalent to a free-space electric field strength of 200 volts-per-meter rms (V/m) and a free-space magnetic field strength of 0.5 ampere-per-meter rms (A/m).

2. Exposures to CW power density levels greater than 10 mW/cm^2 are permissible to a maximum of 25 mW/cm^2 based upon an average energy density of 1 milliwatt-hour per square centimeter (mWh/cm^2) averaged over any 0.1 hour period. For example, at 25 mW/cm^2, the permissible exposure duration is approximately 2.4 minutes in any 0.1 hour period.

3. For repetitively pulsed microwave sources, the average field strength or power density is calculated by multiplying the peak-pulse value by the duty cycle. The duty cycle is equal to the pulse duration in seconds times the pulse repetition rate in Hertz. Exposure during an eight-hour workday shall not exceed the following values which are averaged over any 0.1 hour period:

Power Density	10 mW/cm^2
Energy Density	1 mWh/cm^2
Mean Squared Electric Field Strength	40,000 V^2/m^2
Mean Squared Magnetic Field Strength	0.25 A^2/m^2

4. Exposure is not permissible in CW or repetitively pulsed fields with an average power density in excess of 25 mW/cm^2 or approximate equivalent free-space field strengths of 300 V/m or 0.75 A/m.

*Under conditions of moderate to severe heat stress, the recommended values may need to be reduced. Therefore, these values should be used as guides in the control of exposure to microwave energy and should not be regarded as a fine line between safe and dangerous levels.

B. Also, according to the Radiation Control for Health & Safety Act of 1968(PL 90-602) no microwave oven manufactured after October 6, 1971 shall emit microwave radiation exceeding one milliwatt per square centimeter at any point five centimeters (approximately two inches) or more from the external surface of the oven prior to purchase. After purchase, the density of radiation emitted shall not exceed five milliwatts per square centimeter at any point five centimeters or more from the external surface of the oven. In addition the Federal Law stipulates that all ovens shall have a minimum of two operative safety interlocks which cut off power when the oven door is opened and one of the interlocks must be concealed.

PROTECTIVE MEASURES

1. Unauthorized persons should be prohibited from microwave areas. Those areas which may exceed the permissible limits should be posted with caution signs and other warning devices, including visible or audible signals. Equipment power should be shut off when not in use.

2. Persons should not make detailed visual inspections of microwave equipment components, such as radiator, reflector, wave guide opening, wave guide horn, magnetron or klystron tube during periods of transmission or when power is otherwise applied.

3. Dummy loads, such as water loads, should be used to absorb the energy output of the transmitter while in operation or test.

4. Absorbent screening should be installed to shield personnel, and calculations made to determine areas of probable unsafe exposures.

5. Where computations reveal that areas of personnel occupancy are potentially within a hazardous zone, survey monitoring should be conducted, and records of such measurements retained.

6. Precautions must be taken to preclude injuries from contact with high voltage; also, surveys should be conducted to determine the extent of incidental X-Rays produced in some high-power installations.

MEDICAL CONTROL Where it is known or suspected that workers will be potentially exposed to microwave radiation in excess of permissible limits, a pre-placement medical examination should be given the worker. Particular attention should be given to a slit-lens examination of the eyes

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RESPIRATORY PROTECTIVE DEVICES

General

Respiratory protective devices are secondary methods of defense against inhalation of dusts, fumes, mists, vapors, and gases. Their use is ordinarily confined to operations where the reduction of atmospheric impurities to a safe level by ventilation or other suitable means is impracticable.

Types of Respiratory Protective Devices

In this country respirators indicate devices which cover the nose and mouth but not the eyes. Masks are made to protect the entire face, including the eyes. Hoods and helmets enclose the entire head and varying portions of the upper part of the body.

Respirators and masks may be divided into two main groups. The first affords protection by removing the atmospheric contaminants by means of suitable filters. These may consist of cloth or paper filters or fibrous media which will remove particulate matter, such as silica dust and lead fume, or cartridges or canisters containing absorbents, adsorbents, or catalysts which will remove gases and vapors, such as hydrogen chloride, carbon tetrachloride, and carbon monoxide. Various combinations of these filtering media can be used.

The second type consists of devices in which fresh air is supplied to the respirator or mask. These are usually called "supplied air respirators" or "self-contained breathing apparatus". These may be of the hose type in which air is supplied by means of a hose or tube, or of the self-contained type in which the oxygen or air is provided from a container carried by the wearer. Hoods and helmets are ordinarily of the hose type.

Use of Respiratory Protective Devices

The protection provided by these devices is ordinarily greatest for hoods and helmets which are supplied with air or oxygen and least for filter respirators. The filter respirators are not safe to use in concentrations of gases or vapors which may be dangerous to life or which may injure the eyes. If such an atmosphere must be entered, the minimum amount of protection should be that of a full face mask. For oxygen-deficient atmospheres, supplied air or oxygen devices must be used. **While the respirators approved by the NIOSH are quite efficient in removing the contaminant for which they are designed, the over-all efficiency also depends on a perfect fit of the facepiece. This is difficult to obtain without considerable effort, and therefore the protection offered by such respirators is often less than what is anticipated.**

As a general rule, reliance on a filter-type respirator for protection against dusts, vapors, or gases in excess of ten times the Threshold Limit Values* for prolonged exposure is not advisable. The longer the period of exposure, the higher the concentration, the less desirable the use of a filter respirator, and the greater the need for an air-supply device.

Respirators approved for the protection against the inhalation of toxic or highly toxic dusts and similar dispersoids can be used for protection against the inhalation of pneumoconiosis-producing and nuisance dusts, but respirators approved only for the protection against the inhalation of pneumoconiosis-producing and nuisance dusts shall not be used for protection against the inhalation of toxic or highly toxic dusts and similar dispersoids.

***As recommended by the American Conference of Governmental Industrial Hygienists**

Care of Respiratory Protective Devices

Respirators and masks, like most other equipment, require regular maintenance and repair at given intervals. The individual system or the central system can be used. However, the central system has proven by far the more effective.

The cleaning of a respirator or mask should be done by first removing all dust and dirt. All parts should be disassembled and inspected, such as the facepiece, filter or canister and holder, expiration valve, and head strap. The facepiece should be soaked in a cleaning solution, scrubbed, rinsed, blown off with compressed air, and dried. The cleaning solution can range from soap and water for ordinary dusts to a proper solvent recommended by the respirator or mask manufacturer for the removal of paints and the like. Defective equipment should be removed from use and repaired and sterilized. When the respiratory protective device has been properly cleaned and sterilized, it should be placed in a clean paper or plastic container and stored for future use.

Program Responsibility

Respirators and masks are not a part of the worker's wearing apparel. They are safety devices and should be supplied by the employer. The employer's responsibility does not cease with their purchase. He must distribute them to all workers who need them; and he must tell the employees how, when, and where to use them. It is very important that every worker be educated in the proper care and use of these protective devices. This requires incessant instruction and adequate supervision.

The American National Standard, ANSI, Z88.2-1969, Practices for Respiratory Protection, contains much valuable information on the use of respiratory protective devices, including the following:

Guide for Selection of Respirators

Hazard	Respirators
Oxygen Deficiency	Self-contained breathing apparatus. Hose mask with blower. Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm.
Gas and Vapor Contaminants Immediately dangerous to life or health.	Self-contained breathing apparatus. Hose mask with blower. Air-purifying, full facepiece respirator with chemical canister (gas mask). Self-rescue mouthpiece respirator (for escape only). Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm.
Not immediately dangerous to life or health.	Air-line respirator. Hose mask without blower. Air-purifying, half-mask or mouthpiece respirator with chemical cartridge.

(Cont.)

Hazard	Respirators
Particulate Contaminants Immediately dangerous to life or health.	Self-contained breathing apparatus. Hose mask with blower. Air-purifying, full facepiece respirator with appropriate filter. Self-rescue mouthpiece respirator (for escape only). Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm.
Not immediately dangerous to life or health.	Air-Purifying, half-mask or mouthpiece respirator with filter pad or cartridge. Air-line respirator. Air-line abrasive-blasting respirator. Hose mask without blower.
Combination gas, vapor, and particulate contaminants Immediately dangerous to life or health.	Self-contained breathing apparatus. Hose mask with blower. Air-purifying, full facepiece respirator with chemical canister and appropriate filter (gas mask with filter). Self-rescue mouthpiece respirator. (for escape only). Combination air-line respirator with auxiliary self-contained air supply or an air-storage receiver with alarm.
Not immediately dangerous to life or health.	Air-line respirator. Hose mask without blower. Air-purifying, half-mask or mouthpiece respirator with chemical cartridge and appropriate filter.

The safety and health standards promulgated by the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), relative to the proper selection of respiratory protective devices, maintenance, cleaning, storage, and assurance of their correct use are now mandatory. It is recommended that Regulation 29 CFR 1910.134 of the OSHA Safety and Health Standards be comprehensively read in its entirety.

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RESPIRATOR FIT TEST, INSPECTION AND CLEANING

FULL AND HALF-FACE RESPIRATOR FIT TEST

Before the initial use, and periodically, a fit test should be done to assure that the respirator fits properly and does not leak. Note - The respirator will not fit properly with a beard, and it may not fit with a mustache. The half-face respirator fits best when the person is clean shaven. The following check should be done before each use.

Negative Pressure Test

a. Put on respirator and tighten adjusting straps.
b. Cover the inlet opening(s) of the respirator cartridge(s) with the palms of the hand(s). Apply a minimum amount of hand pressure to the cartridges so as not to affect the respirator-face seal.
c. Inhale gently and hold breath for ten seconds. If the facepiece collapses slightly and no leakage of air into the facepiece is detected, it can be reasonably assumed that the respirator-face seal is adequate. If not, readjust mask or head straps and repeat procedure. Note that it is sometimes necessary to try a different size or a different respirator manufacturer.

Positive Pressure Test

a. Put on respirator and tighten adjusting straps.
b. Cover the outlet opening of the exhalation valve with the palm of a hand.
c. Exhale gently and hold breath for ten seconds. If the facepiece bulges slightly and no leakage of air out of the facepiece is detected, it can be reasonably assumed that the respirator-face seal is adequate.

Negative Pressure Test

Qualitative Fit Tests

Irritant Smoke with High Efficiency (HEPA) Filter Cartridge

a. Have worker put on the respirator and tighten adjusting straps.
b. Instruct worker to close their eyes.
c. Hold the smoke tube two feet from the worker's face and direct the smoke over the front and sides of the respirator.
d. If the worker detects any smoke penetration, have them inspect respirator for any defective valves or loose cartridges and then readjust fit of respirator. Repeat b and c.
e. If the worker does not detect any smoke penetration, move the smoke tube six inches from the worker's face and direct the smoke over the front and sides of the respirator.
f. If no smoke penetration is detected, have the worker perform the following exercises while directing smoke at potential points of leakage in the respirator-face seal.

* normal breathing
* deep breathing
* turning head from side to side
* nodding head up and down
* talking
* smiling

A satisfactory fit has been achieved if the worker is not able to detect any smoke penetration.

Isoamyl Acetate with Organic Vapor Cartridge

a. Instruct the worker to sniff at an open container of liquid isoamyl acetate (banana oil) to test their ability to detect the odor. Use the irritant smoke test with HEPA filters if the worker is unable to detect the isoamyl acetate odor.
b. Have worker put on the respirator and tighten adjusting straps.
c. Saturate a piece of cloth or sponge with liquid isoamyl acetate and place in a dish.
d. Instruct the worker to perform the following exercises while passing the fabric or sponge around potential points of leakage in the respirator-face seal.

* normal breathing
* deep breathing
* turning head from side to side
* nodding head up and down
* talking
* smiling

If the worker detects the odor of isoamyl acetate, have them readjust the fit of the respirator and then repeat the test.

A satisfactory fit has been achieved if the worker is not able to detect the odor of isoamyl acetate.

Note - There are some individuals who cannot wear a particular respirator because of facial scars or shape. If this happens try another type or a different respirator manufacturer.

INSPECTION OF HALF AND FULL-FACE RESPIRATOR

A complete inspection of the respirator should be done before each use. Manufacturers guidelines may vary, so read the literature for the individual respirator for specific details. The general inspection procedure follows:

1. Check inlet valves for tears, distortions and debris. The inlet valve should be flexible not stiff.

2. Check exhalation valve for tears, distortions and debris. Again, the valve should not be stiff. Grab the rubber stem from inside the respirator and twirl it gently. The exhalation valve should move freely.

3. Check the rubber face piece for tears, distortions, debris and stiffening. (Check faceshield for cracks if full face respirator.)

4. Check the head harness strapping for tears or loss of elasticity.

5. Make sure the cap is on the exhalation valve.

6. Check that the proper filters are in place. Check the number of hours of filters use and replace when necessary. (Record number of hours after each use)

7. Check that gaskets are present where the filters screw in. (Some respirators do not have gaskets.)

8. Remove filters and clean respirator after each use.

CLEANING AND DISINFECTING

The following procedure is recommended for cleaning and disinfecting half and full face respirators. Respirators should be cleaned after each use.

1. Remove the filters, cartridges or canisters.

2. Wash rubber face piece in a cleaner disinfectant or detergent solution which will effectively kill bacteria and clean dirt from the parts of the respirator. Quaternary ammonium compounds are generally excellent for this purpose. The respirator may be totally immersed in these solutions and cleaned. (Note - a solution of 2 ml bleach to 1 liter of water or 0.8 ml tincture of iodine to 1 liter of water may be used.)

3. Rinse completely in clean warm water.

4. Air dry in clean area.

5. Clean other respirator parts as recommended by manufacturer.

Massachusetts Department of Labor and Industries
James F. Snow, Commissioner

Division of Occupational Hygiene
Richard Levine, Director

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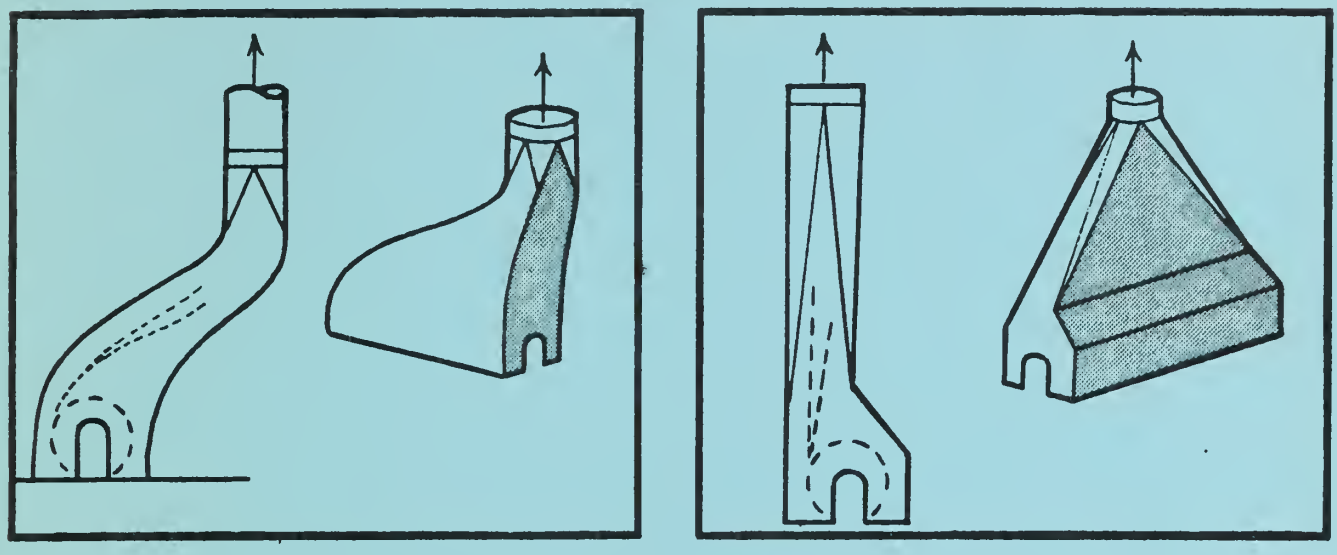
West Newton, MA 02165
Telephone 617/969-7177

No. 1402 February 1987

PLANERS



For best results, it is important that the shape of the hood follow as closely as possible the trajectory of the chips. If rebound of the chips is necessary in those cases where the chips are not thrown vertically, it is desirable to have the angle of rebound acute.

EXHAUST VOLUME

Single Planer	Exhaust Volume (Cubic Feet per Minute)
Up to 20 in. knives	785
Over 20 in. to 26 in. knives	1,100
Over 26 in. to 32 in. knives	1,400
Over 32 in. to 38 in. knives	1,765
Over 38 in. knives	2,200

Double Planer	Exhaust Volume (Cubic Feet per Minute)		
	Bottom	Top	Total
Up to 20 in. knives	550	785	1,335
Over 20 in. to 26 in. knives	785	1,100	1,885
Over 26 in. to 32 in. knives	1,100	1,400	2,500
Over 32 in. to 38 in. knives	1,400	1,800	3,200
Over 38 in. knives	1,400	2,200	3,600

Note: The branch ducts should be sized to maintain a duct velocity of at least 4,000 fpm. at all times.

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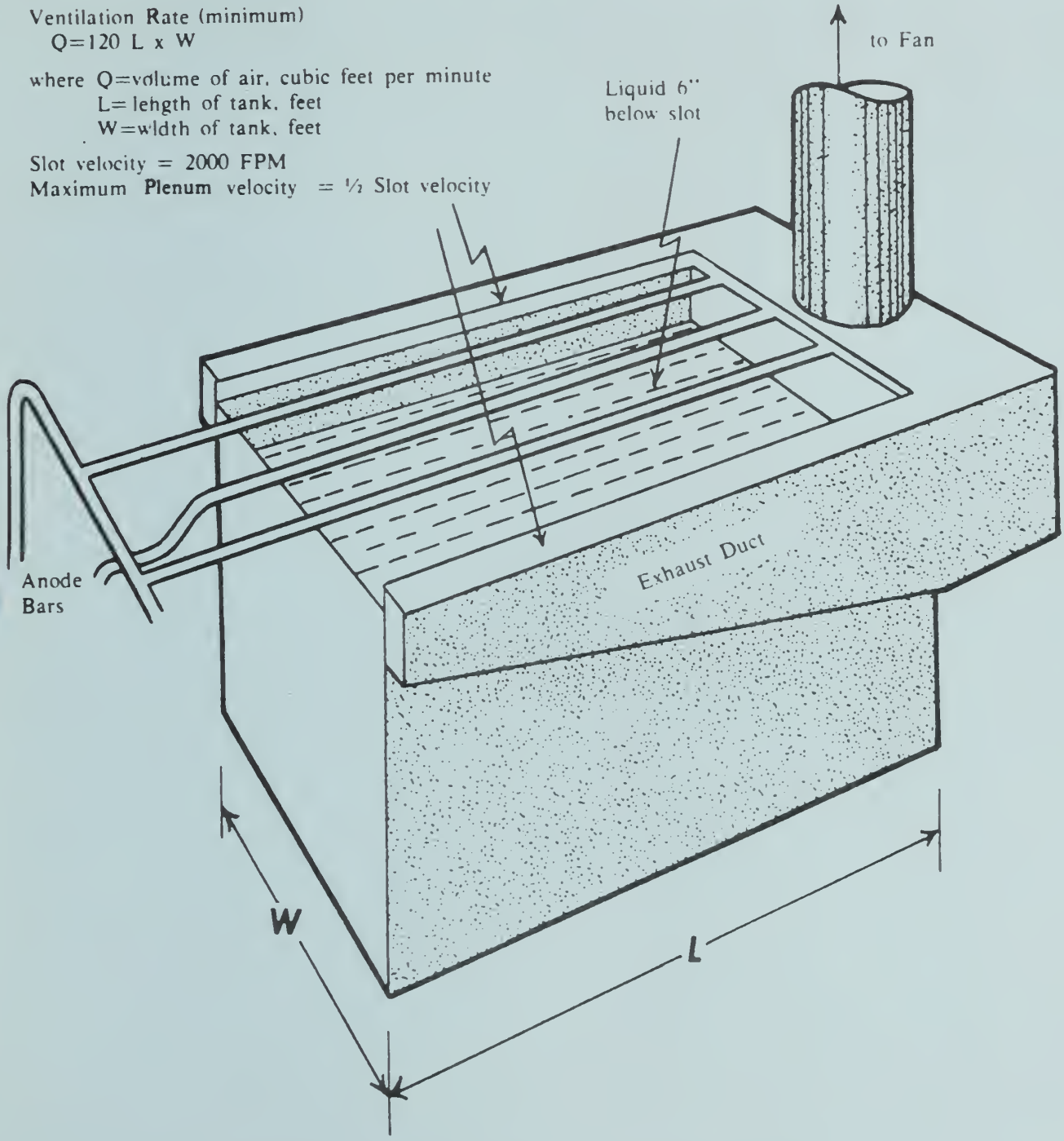
No. 1122 Supersedes No. 410 December, 1981

PLATING TANKS

Ventilation Rate (minimum)
Q=120 L x W

where Q=volume of air, cubic feet per minute
L= lehgth of tank, feet
W=wldth of tank, feet

Slot velocity = 2000 FPM
Maximum **Plenum** velocity = ½ Slot velocity



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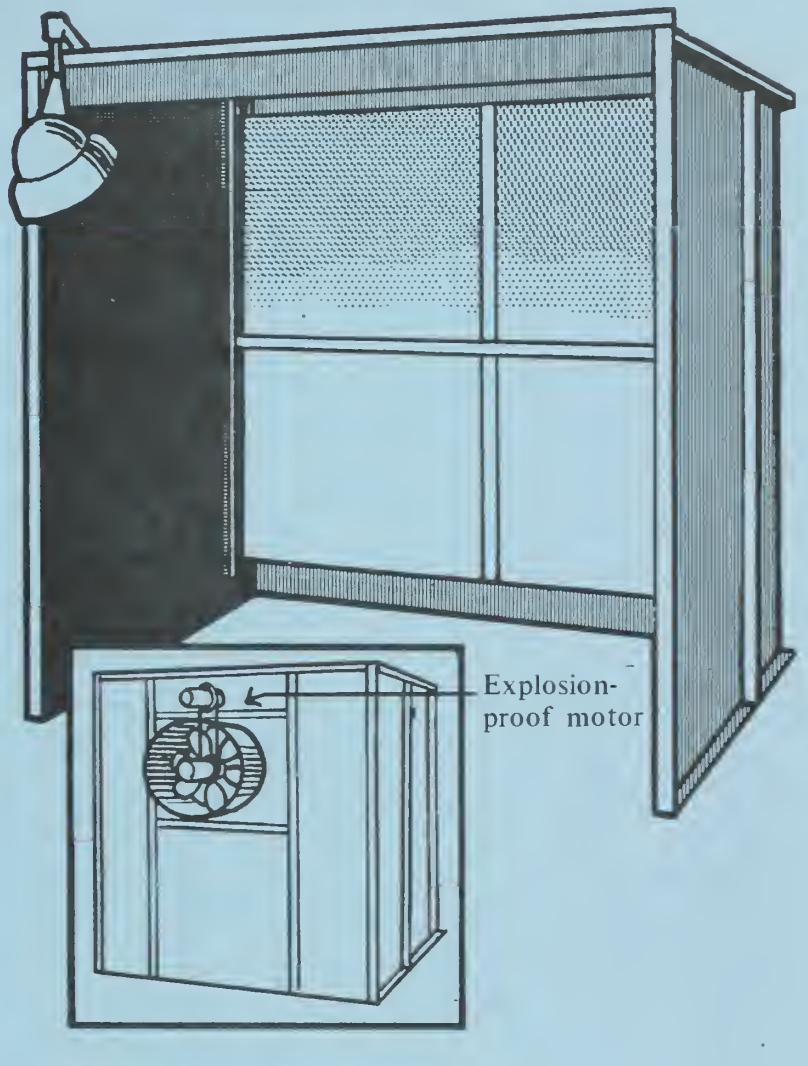
No. 1094 Supersedes No. 413 April, 1977

SPRAY BOOTHS

Design Specifications.

The design of the booth must be planned to fit the work. Therefore, the cross-sectional area and depth are obviously determined by the size and shape of the object to be sprayed. It is desirable to locate the sprayer outside of the booth, but if the work is of such a nature as to require the worker to be located within the booth, the dimensions should be such as to permit ample work room so that the worker may hold the spray apparatus well away from his face. The operator should be able to reach all parts of the work without finding it necessary to stand between the spray gun and the air outlet. A turntable is advisable so that the object being sprayed can be rotated and so permit the sprayer to reach all surfaces without changing his position.



Velocity Requirements.

The minimum velocity requirements are set forth in the following table:

Booth Area in Square Feet Height x Width	Air Pressure on Spray Gun: Under 65 lbs. Minimum Face Velocity	Air Pressure on Spray Gun: 70 lbs. to 95 lbs. Minimum Face Velocity
4 to 6	200 f.p.m.	300 f.p.m.
7 to 16	150 f.p.m.	225 f.p.m.
17 to 36	125 f.p.m.	175 f.p.m.
Over 36	125 f.p.m.	150 f.p.m.

Air Volume Requirements. The required fan capacity is easily calculated by multiplying the cross-sectional (face) area of the booth (A) by the required velocity (V). The rate of airflow (Q) is expressed in cubic feet per minute. Q=AV.

Booth and Pipe Construction. The booth, floor, baffles, and duct work should be fabricated of at least 22 gauge steel, reinforced with angle iron. The diameter of the discharge duct should be calculated to give a duct velocity not greater than 2000 l.f.m. Elbows should have a centerline radius of 1.5 to 2 diameters and be made of 7 sections.

Baffles or distribution plates may be necessary to create evenly distributed airflow through the booth. The number of plates, the size and spacing, depend upon the cross-sectional dimensions of the booth. Where a horizontal duct is connected at the rear of the booth, the baffles should be located in a plane 3/4 of the duct diameter in front of the rear of the booth. Where a vertical duct connects with the top of the booth, the baffles should be located in a plane 6 inches forward of the front edge of the duct.

Filters should be used to collect the paint overspray prior to entering the exhaust duct system. The filters should be noncombustible or of a type having a combustibility not in excess of Class 2 filters, as listed by Underwriters' Laboratories, Inc. Visible gauges or audible alarm or pressure activated devices shall be installed to indicate or insure that the required air velocity is maintained.

BAFFLE NUMBER AND SPACING

Cross Sectional Dimensions--Ft. (H x W)*	No. of Panels	Spacing - Inches Between Panels	Top and Side	Bottom
3 x 3*	1			
6½ x 4	3	4	6	12
6½ x 6	4	4	6	12
6½ x 8	6	4	10	12
6½ x 10	9	6	10	18

*For booths 3 ft. x 3 ft. and smaller 1 panel 6 in. larger than fan diameter

Exhaust Fans. Since the resistance of the exhaust system is usually quite low, a propeller type fan may be utilized. The fan blades should be made of nonferrous material. The fan should be belt driven by an explosion-proof motor located outside of the duct or booth.

Points of Discharge. The point of discharge should be extended not less than 6 feet above the roof and should be located as far as possible from any windows, doors or other inlets into occupied spaces. The end of the discharge duct should be equipped with a low resistance weather cap.

Air Supply. Fire regulations usually permit doors communicating with fireproof rooms to remain open if equipped with automatic closing devices operative in the event of fire. If doorway openings are too small in area, drafts of air may cause discomfort to those workers near them. The total area of such openings in square feet should be such that the air velocity through them does not exceed 200 f.p.m. If necessary, supplementary openings in the upper part of a wall near the ceiling equipped with automatic closing devices may be provided.

Advisory Service. The Division of Occupational Hygiene urges plant managers and those engaged in the erection of exhaust systems to confer with it when contemplating installation of spray coating booths.

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
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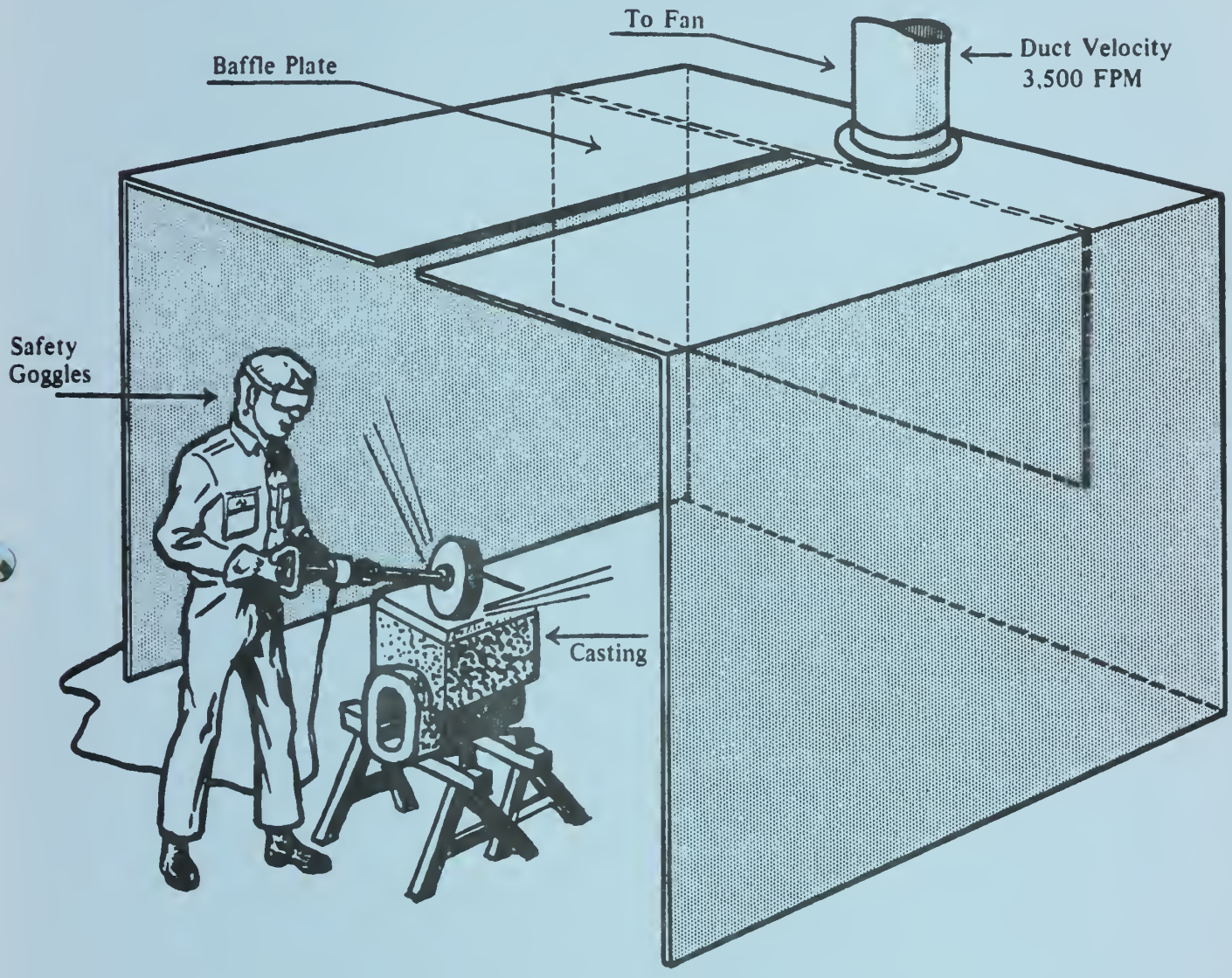
No. 1147 Supersedes No. 1017 August, 1979

PORTABLE GRINDERS



PRODUCE A FACE VELOCITY OF NOT LESS THAN 100 F.P.M.
See Ventilation Data Sheet No. 16

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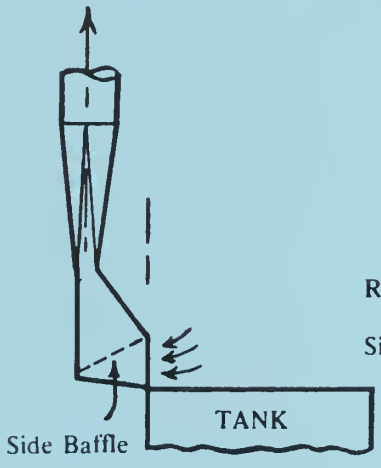
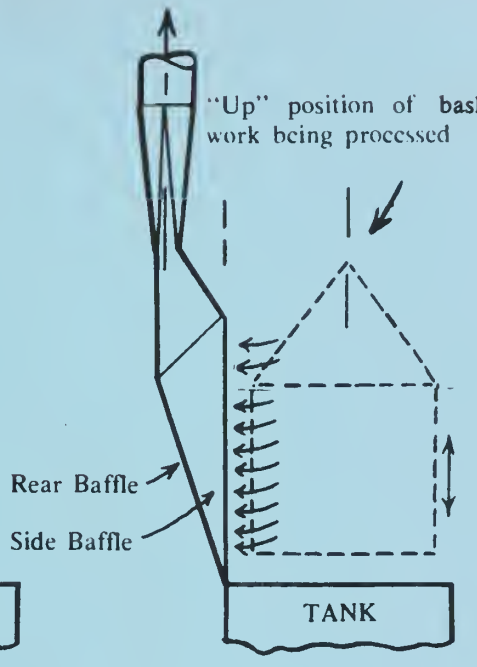
No. 1012 Supersedes No. 423 June, 1981

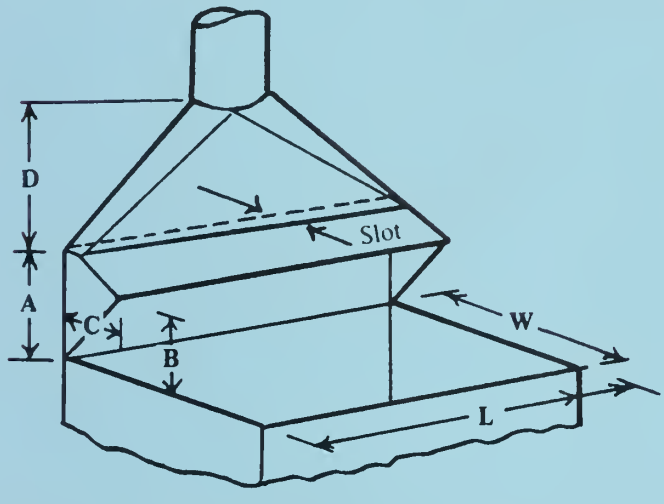
OPEN TANKS

Location of rear-type hood for various operating conditions.



"Up" position of basket with work being processed





Typical rear-type exhaust hood.

HOOD DIMENSIONS, INCHES

Tank Width	A	B	C	D
24	12	8	9	19
30	16	12	9	19
36	20	12	9	19

Ventilation Rate (minimum)
$Q = V \times L \times W$

Where Q=volume of air, cubic feet per minute
V=controlling velocity, feet per minute (see table)
L=length of tank, feet
W=width of tank, feet

Velocity-operation	V
Bright dip	200
Hot processes	200
Cold processes	100

Velocity through slot-2000-3000 f.p.m.
Duct velocity-2000 f.p.m.

Note:-For tanks longer than 4 feet, more than one duct and transition piece are needed.

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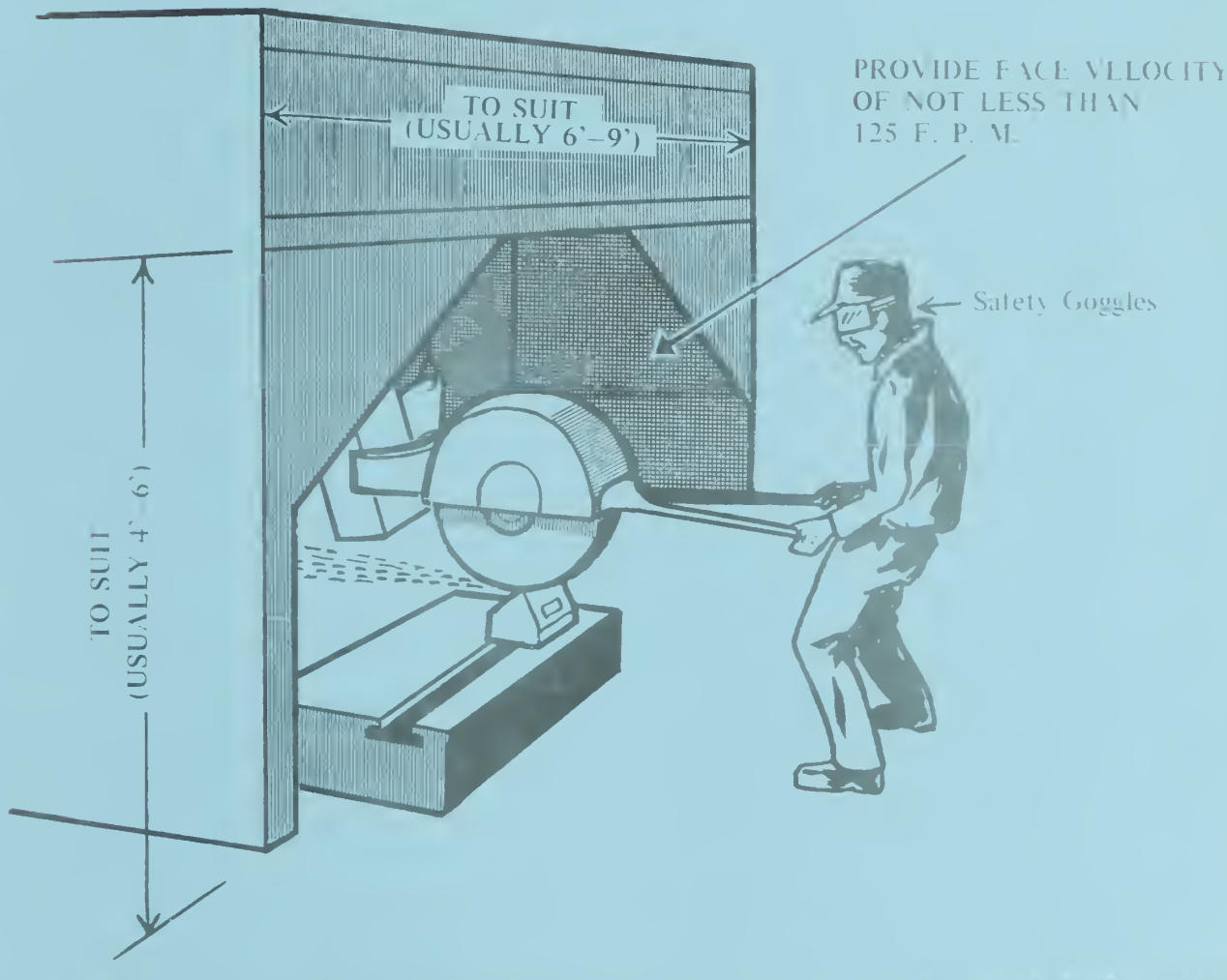
No. 1259 Supersedes No. 1095 January, 1983

SWING FRAME GRINDERS



NOTE: DUCT VELOCITIES OF AT LEAST 3500 F.P.M. SHOULD BE MAINTAINED. FLOOR OF BOOTH SHOULD BE CLEANED PERIODICALLY.

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No. 1107 Supersedes No. 1015 April, 1980

BLASTING ROOMS

ABRASIVE

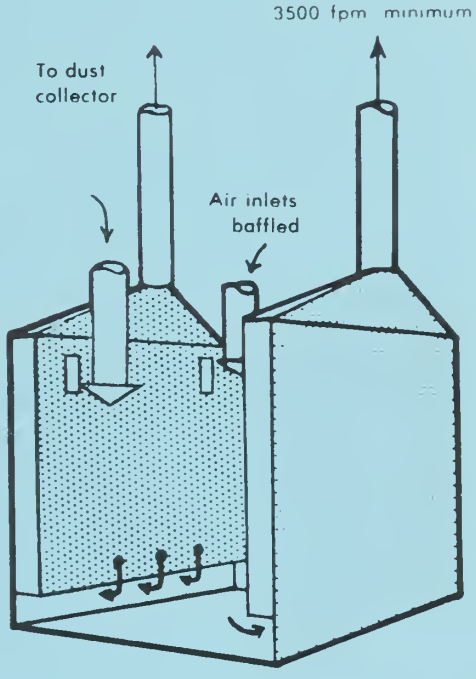
Sand, steel shot and grit, aluminum oxide and silicon carbide are all used as abrasives for blasting. Where production requirements permit, abrasives other than sand are preferable from a health standpoint.

RESPIRATORY PROTECTION

In addition to the ventilation requirements described below, all workers performing abrasive blasting should be provided with and required to wear filtered air supplied abrasive blasting helments approved by the U.S Department of Health, Education and Welfare, National Institute for Occupational Safety and Health (NIOSH). (See Recommended Safe Practices, Respiratory Protection Data Sheet No. 11.)

DUST COLLECTOR

Exhaust air should pass through a dust collector before it is discharged to the out of doors. Because of the abrasive nature of the dust, a cyclone is not suitable. A cloth type of collector with sufficient cloth area to permit filtering velocities not exceeding 10 f.p.m. is recommended.



EXHAUST REQUIREMENTS

A minimum exhaust rate of 75 c.f.m. per square foot of floor area is recommended for adequate dust control.

PLENUM CHAMBERS

Plenum chambers should be built to dimensions that will result in air velocities of approximately 200 f.p.m. when fulfilling exhaust requirements noted above.

AIR INLETS

Air inlets of sufficient number and size should be provided to allow admission of volume of air equal to that exhausted at a rate not to exceed 200 f.p.m. Baffles should be provided to prevent escape of abrasive.

CONSTRUCTION

Rooms should be constructed with tight joints throughout and should be provided with tightly fitting and gasketed doors. Protection of the inside walls from the abrasive is advisable.

LIGHTING

A minimum of 20 foot-candles should be provided at the work. Lamps should be provided with protective coverings to prevent abrasive from striking electric lamp.

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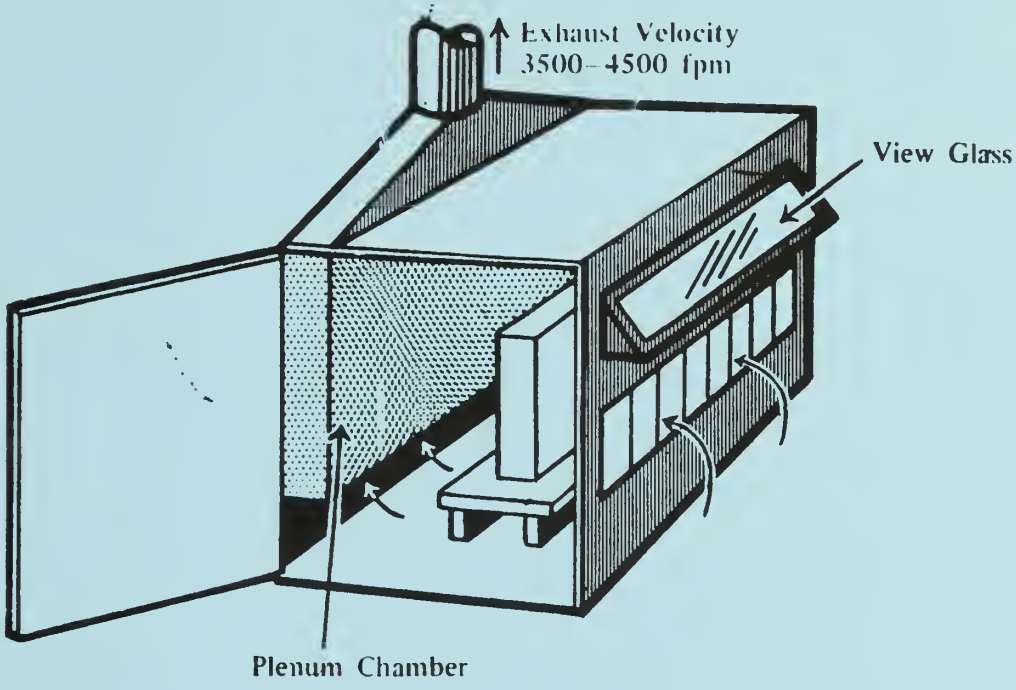
No. 1209 Supersedes No. 1140 July, 1980

GRANITE BLASTING ROOMS



EXHAUST REQUIREMENTS A minimum exhaust rate of 150 c.f.m. per foot of length of opening is recommended for adequate dust control.

PLENUM CHAMBER The plenum chamber should be built to dimensions that will result in air velocities of approximately 200 l.f.m. when the exhaust requirements described above are fulfilled.

CONSTRUCTION Rooms should be constructed with tight joints throughout and should be provided with tight fitting and gasketed doors. Protection of the inside walls from the abrasive is advisable. Window openings should be covered with glass protected by wire screening. Rubber flaps should be maintained in good condition.

LIGHTING A minimum of 20 foot-candles should be provided. Protective coverings should be provided to prevent electric lamps from being hit by the abrasive.

RESPIRATORY PROTECTION **With adequate exhaust, respiratory protection need not be used when the worker is outside the room. For short work periods within the room and when no blasting is being performed, the worker should be provided with and required to wear a filter type respirator approved by the** U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, (NIOSH), Testing and Certification Branch (TCB).

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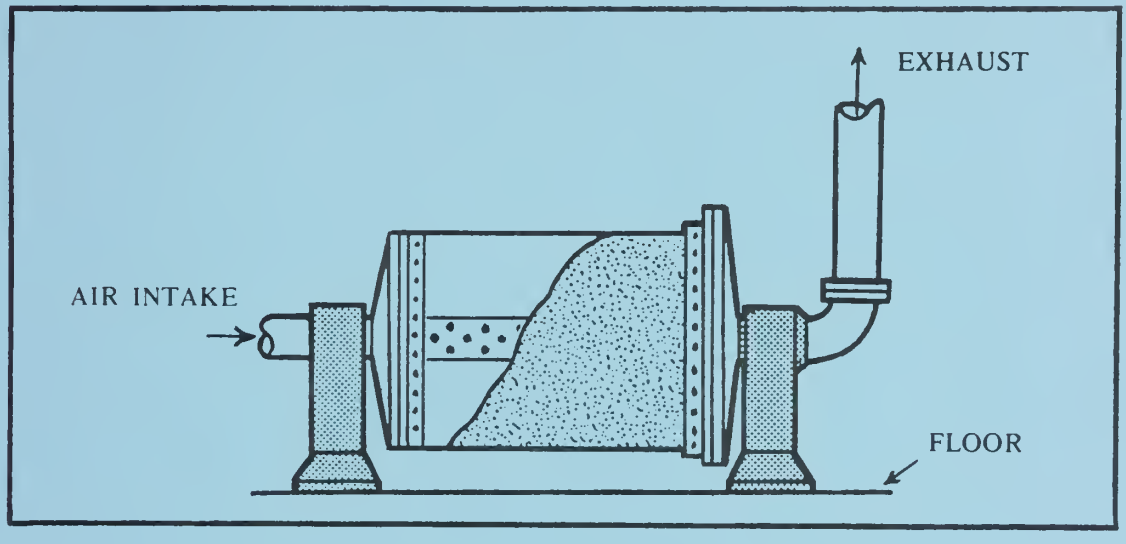
No. 1315 Supersedes No. 1170 June, 1981

TUMBLERS

HOLLOW-TRUNNION TYPE



AIR FLOW REQUIREMENTS

TUMBLING

Diameter of Mill	Diameter of Pipe	C.F.M.
Up. to18"	3"	250
19" to 24"	4"	450
25" to 30"	5"	700
31" to 36"	6"	1000
36" to 42"	7"	1350
42" to 48"	8"	1750
48" to 54"	9"	2200
54" to 60"	10"	2750
60" to 66"	11"	3300
66" to 72"	12"	3950
72"	13"	4600

Duct diameter calculated to give a duct velocity of 5,000 FPM.
Entry loss = 3.25" - 5.00" H_2O (depending upon design)
For lengths over 72" the C.F.M. should be increased proportionately.

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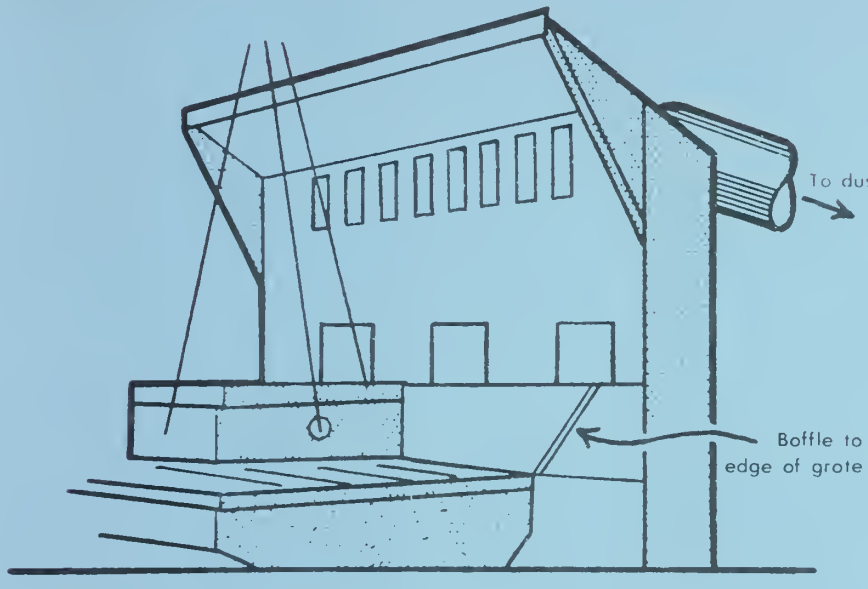
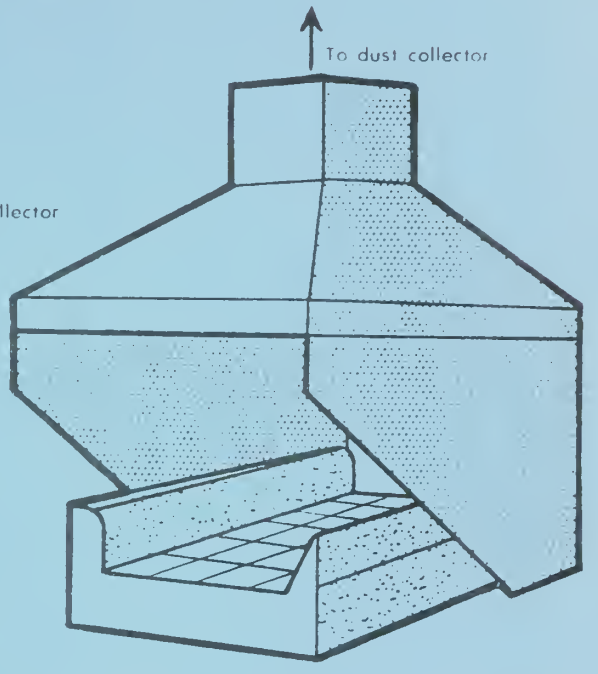
No. 1102 Supersedes No. 480 August, 1979

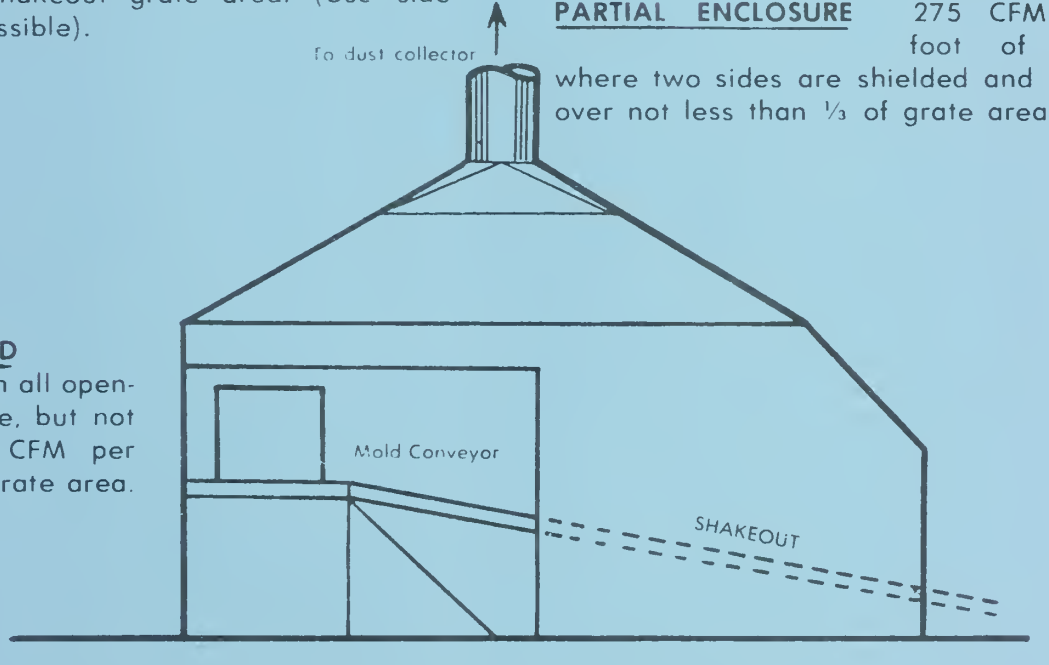
FOUNDRY SHAKEOUT



SIDE HOOD 400-600 CFM per square foot of shakeout grate area. (Use side shields when possible).



PARTIAL ENCLOSURE 275 CFM per square foot of grate area where two sides are shielded and hood extends over not less than ⅓ of grate area.



ENCLOSED HOOD
200 FPM through all openings in enclosure, but not less than 200 CFM per square foot of grate area.

NOTE Maintain a minimum duct velocity of 3500 FPM.

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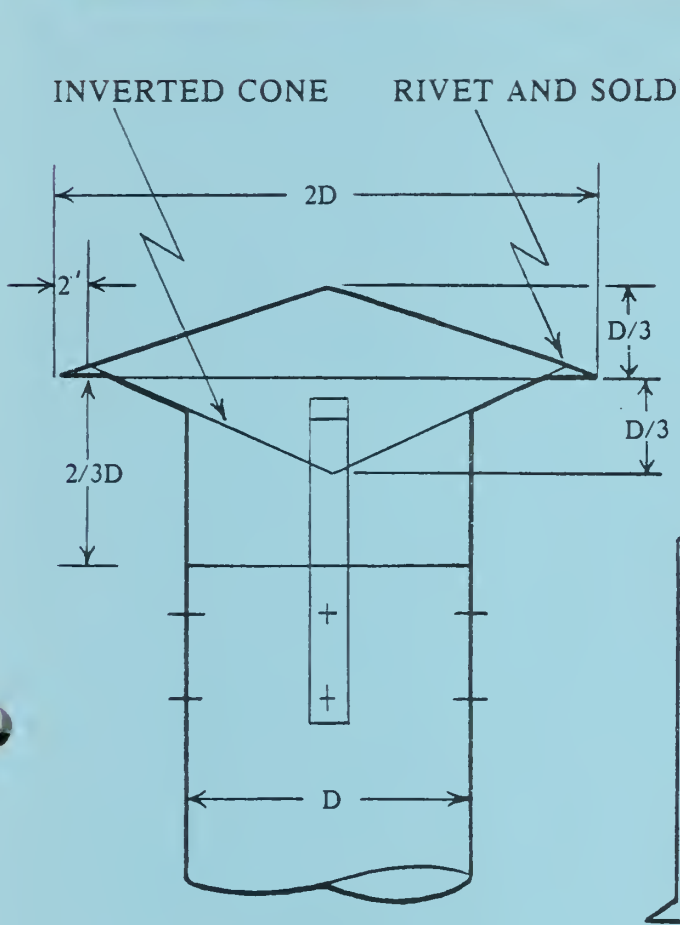
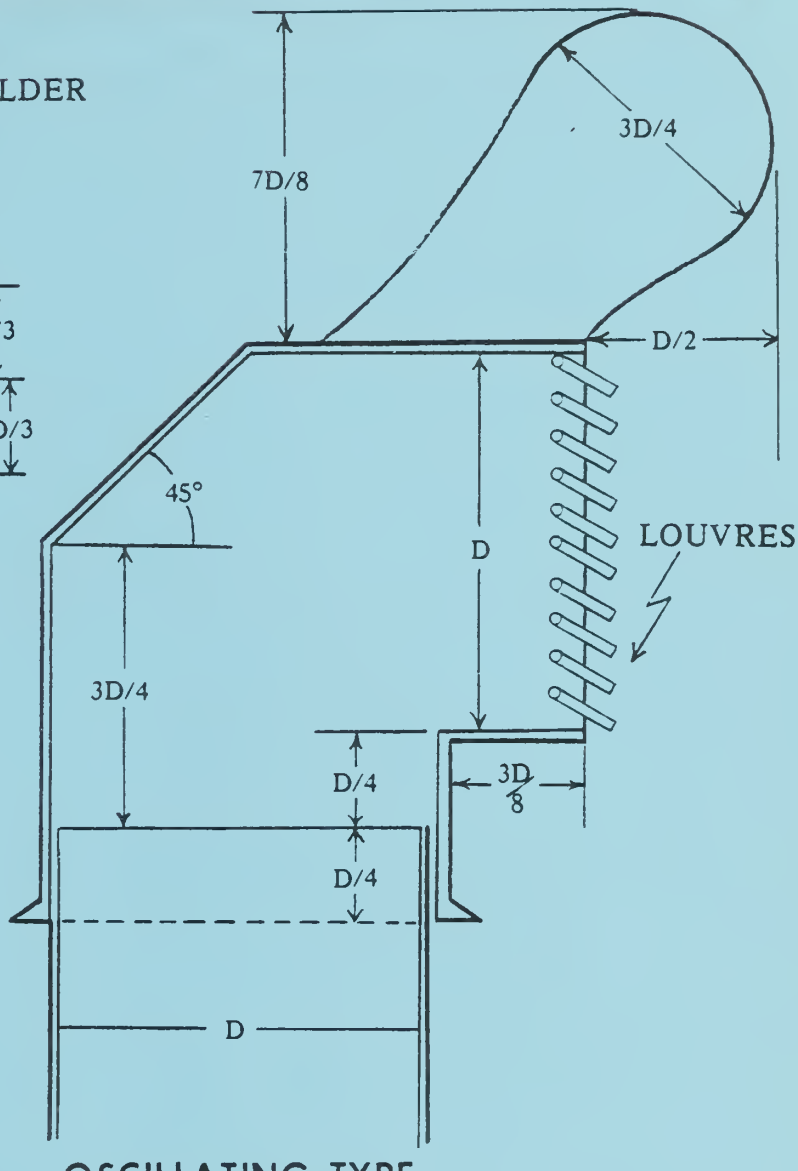
No. 1053 Supersedes No. 484 January 1, 1979

RECOMMENDED SAFE PRACTICES VENTILATION DATA SHEET NO. 11

WEATHER CAPS



STATIONARY TYPE



OSCILLATING TYPE

EXTEND DUCT AT LEAST 8FT. ABOVE ROOF LINE

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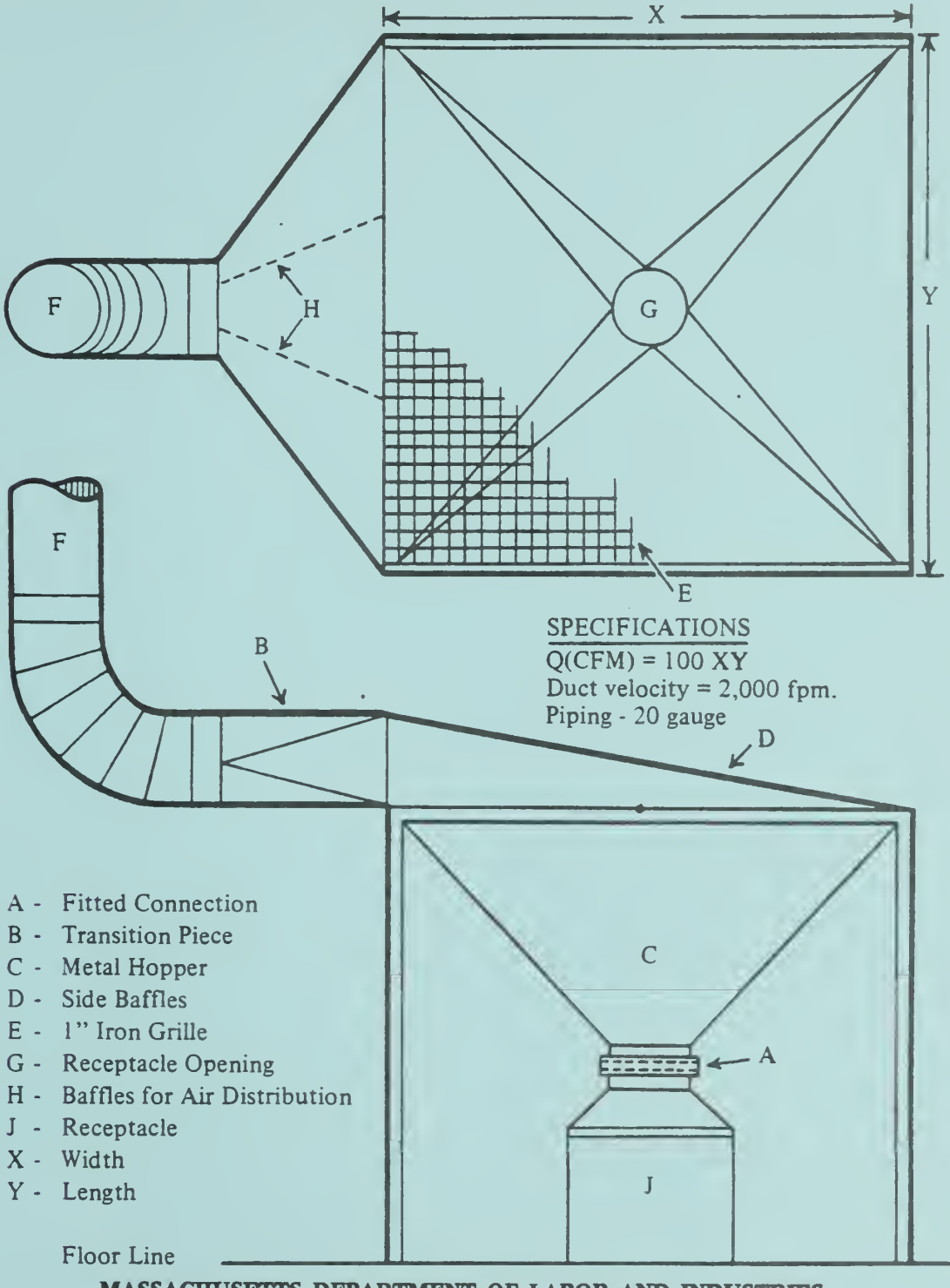
No. 1174 Supersedes 496 July, 1980

SOLDERING BENCH



SPECIFICATIONS

Q(CFM) = 100 XY

Duct velocity = 2,000 fpm.

Piping - 20 gauge

A - Fitted Connection
B - Transition Piece
C - Metal Hopper
D - Side Baffles
E - 1" Iron Grille
G - Receptacle Opening
H - Baffles for Air Distribution
J - Receptacle
X - Width
Y - Length

Floor Line

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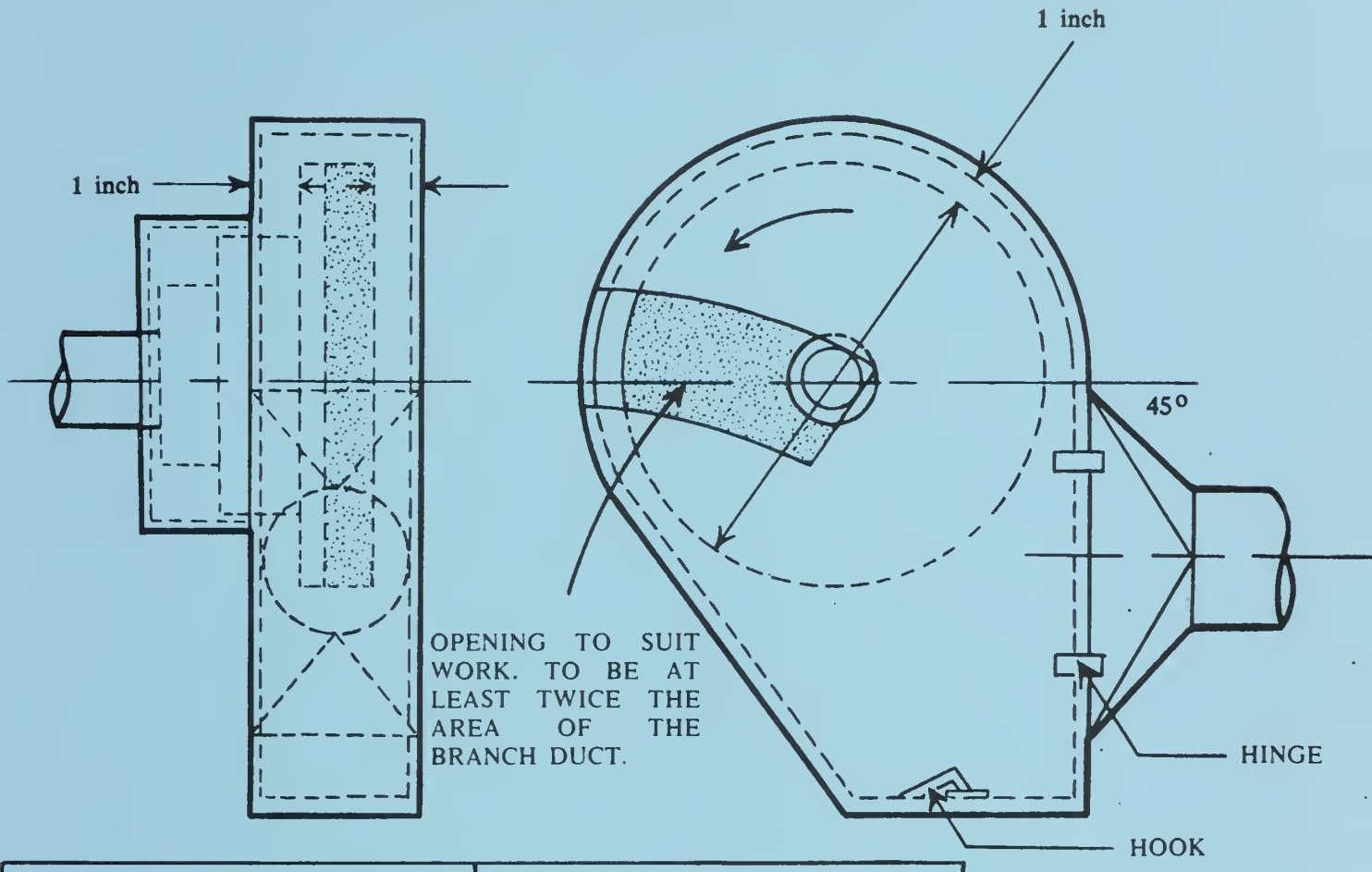
No. 1041 Supersedes No. 915 January, 1979

DISC GRINDER

HORIZONTAL SINGLE - SPINDLE TYPE



DISC DIAMETER, INCHES	EXHAUST VOLUME, CFM
Up to 12	225
Over 12 to 19	400
Over 19 to 30	625
Over 30 to 36	900

MINIMUM
BRANCH DUCT
VELOCITY:
4500 FPM
Entry Loss - 0.65 V.P.
Straight take-off
0.45 V.P. for tapered take-off

Note: Exhaust volume must be increased if a poor enclosure is used.

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
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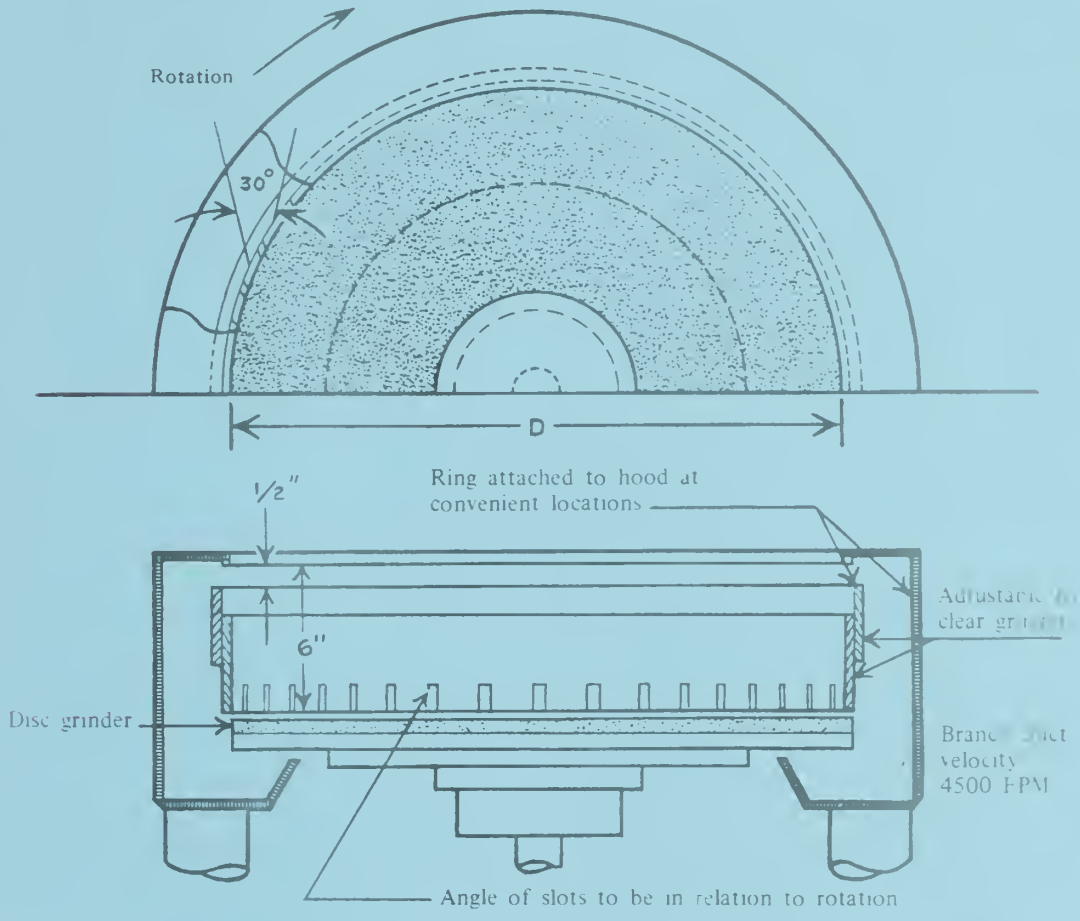
No. 1196 Supersedes No. 1106 September, 1978

DISC GRINDER
VERTICAL SPINDLE TYPE



Disc Diameter, Inches	50% or More of Disc Covered			Disc Not Covered		
	Number*	Exhaust. CFM.	Diameter	Number*	Exhaust. CFM.	Diameter
Up to 20	1	500	4½	2	800	4
Over 20 to 30	2	800	4	2	1,500	5½
Over 30 to 53	2	1,800	6	4	3,600	6
Over 53 to 72	2	3,150	8	5	6,000	7

*Number of exhaust outlets around periphery of hood, or equal distribution by other means

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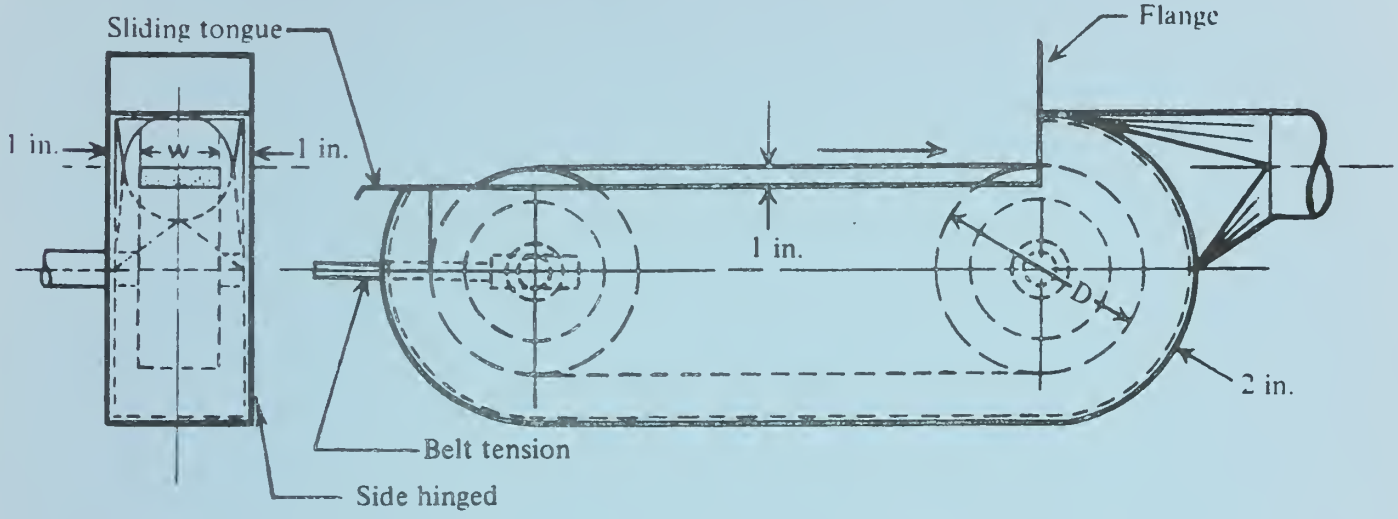
No. 1028
Supersedes No. 585
April, 1980

GRINDING AND POLISHING BELT



Belt width, inches	Exhaust volume, cfm
up to 3	220
3 to 5	300
5 to 7	390
7 to 9	500
9 to 11	610
11 to 13	740

Minimum duct velocity = 4500 fpm branch, 3500 fpm main.
Entry loss = 0.65 velocity pressure for straight take-off.
0.45 velocity pressure for tapered take-off.

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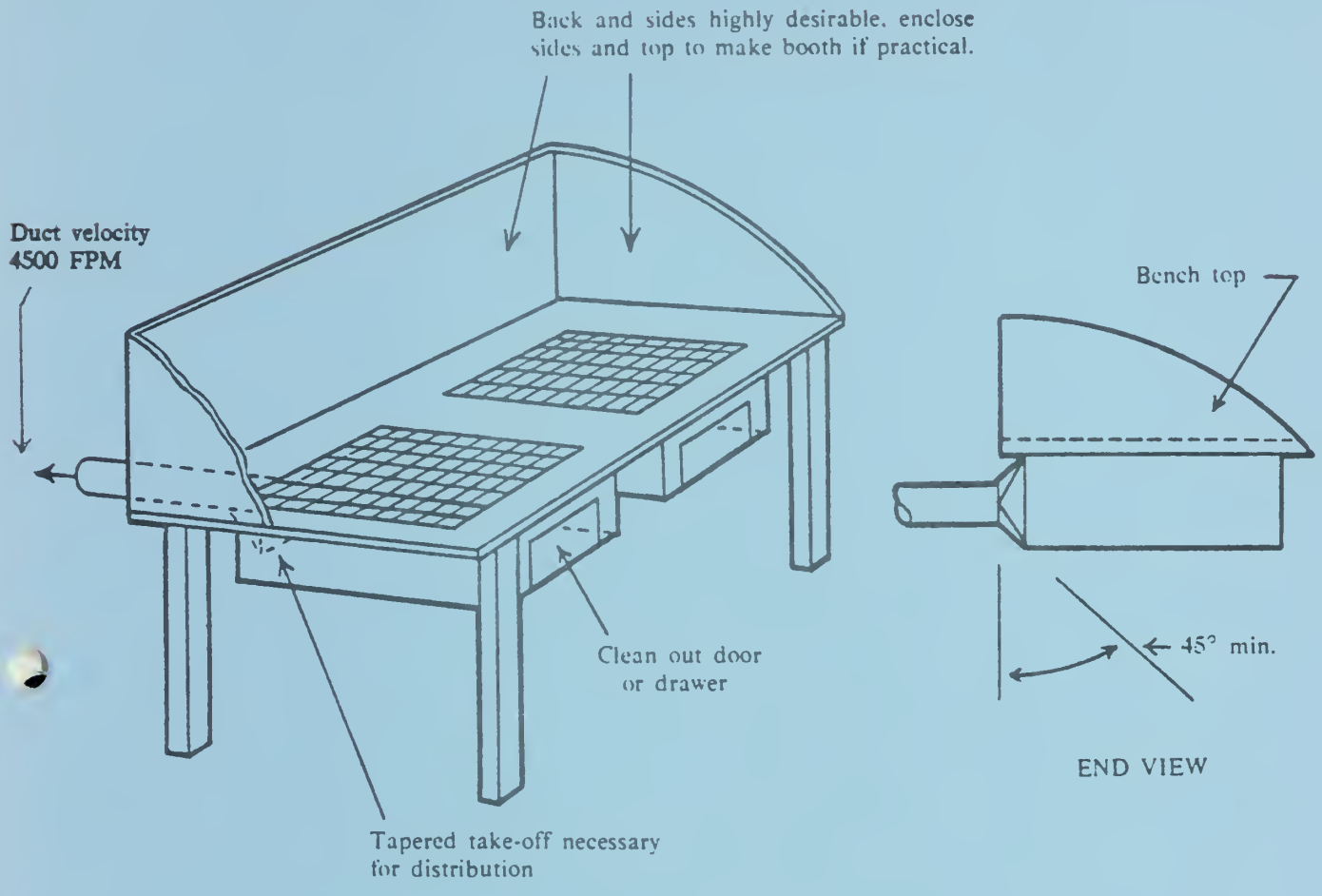
No. 1039 Supersedes No. 586 June, 1981

PORTABLE BENCH GRINDER


Back and sides highly desirable, enclose sides and top to make booth if practical.
Duct velocity 4500 FPM
Bench top
Clean out door or drawer
45° min.
END VIEW
Tapered take-off necessary for distribution

Q=200-400 CFM/sq. ft. of exhaust grille, but not less than 150 CFM per sq. ft. of plan working area.

Q=200 CFM/sq. ft. of plan working area for magnesium (wet type dust collector required).

Q=200-400 CFM/sq. ft. of downdraft floor grilles, but not less than 100 CFM/sq. ft. of plan working area.

For booth enclosures, maintain a minimum face velocity of 100 FPM through all openings.

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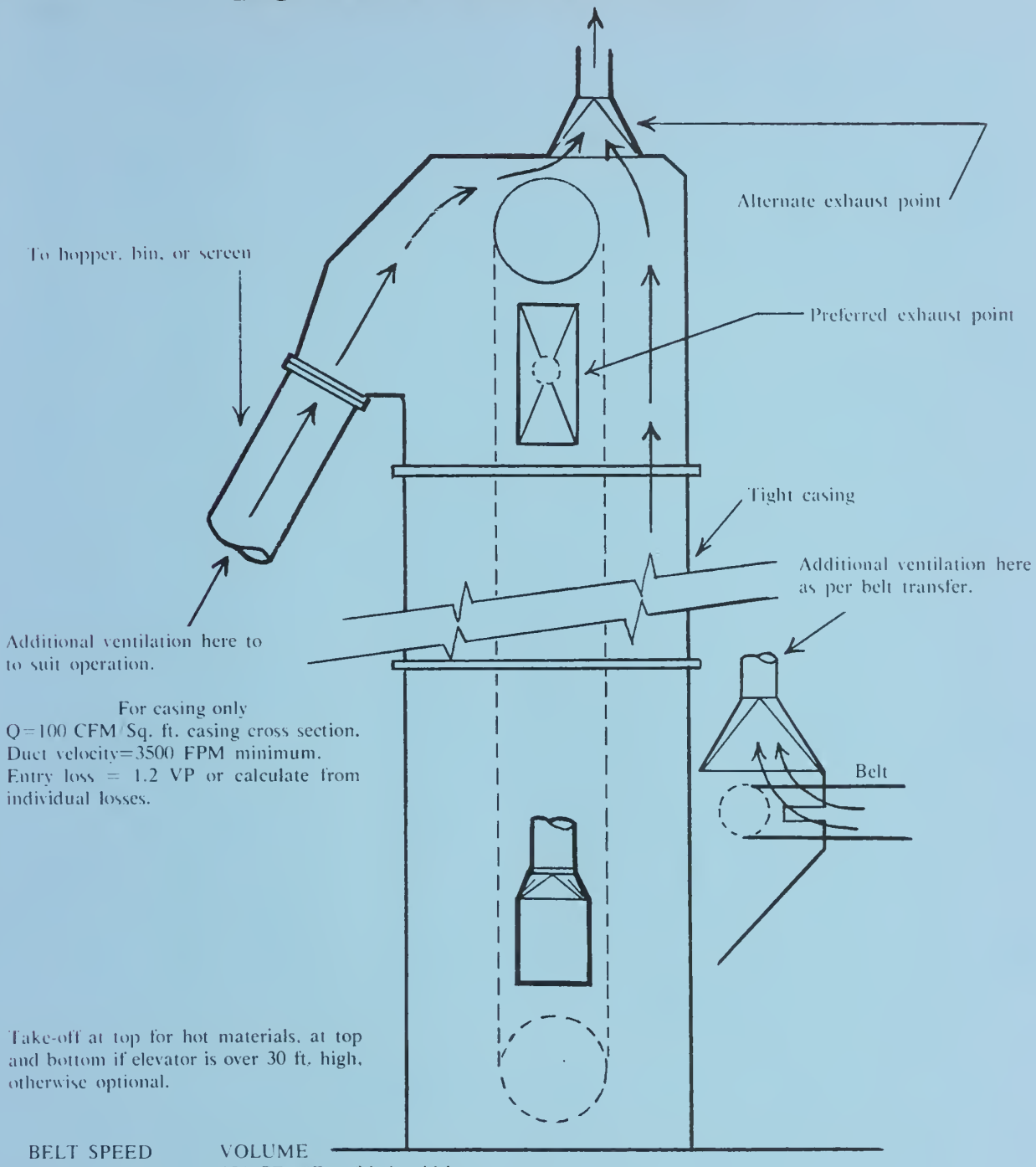
No. 1103 Supersedes No. 587 May, 1979

BUCKET ELEVATOR


Alternate exhaust point
To hopper, bin, or screen
Preferred exhaust point
Tight casing
Additional ventilation here as per belt transfer.
Additional ventilation here to to suit operation.
Belt

For casing only
Q=100 CFM/Sq. ft. casing cross section.
Duct velocity=3500 FPM minimum.
Entry loss = 1.2 VP or calculate from individual losses.

Take-off at top for hot materials, at top and bottom if elevator is over 30 ft. high, otherwise optional.

BELT SPEED	VOLUME
Less than 200 FPM -	350 CFM/Ft. of belt width.
	Not less than 150 CFM/Ft. of opening.
Over 200 FPM -	500 CFM/Ft. of belt width.
	Not less than 200 CFM/Ft. of opening.

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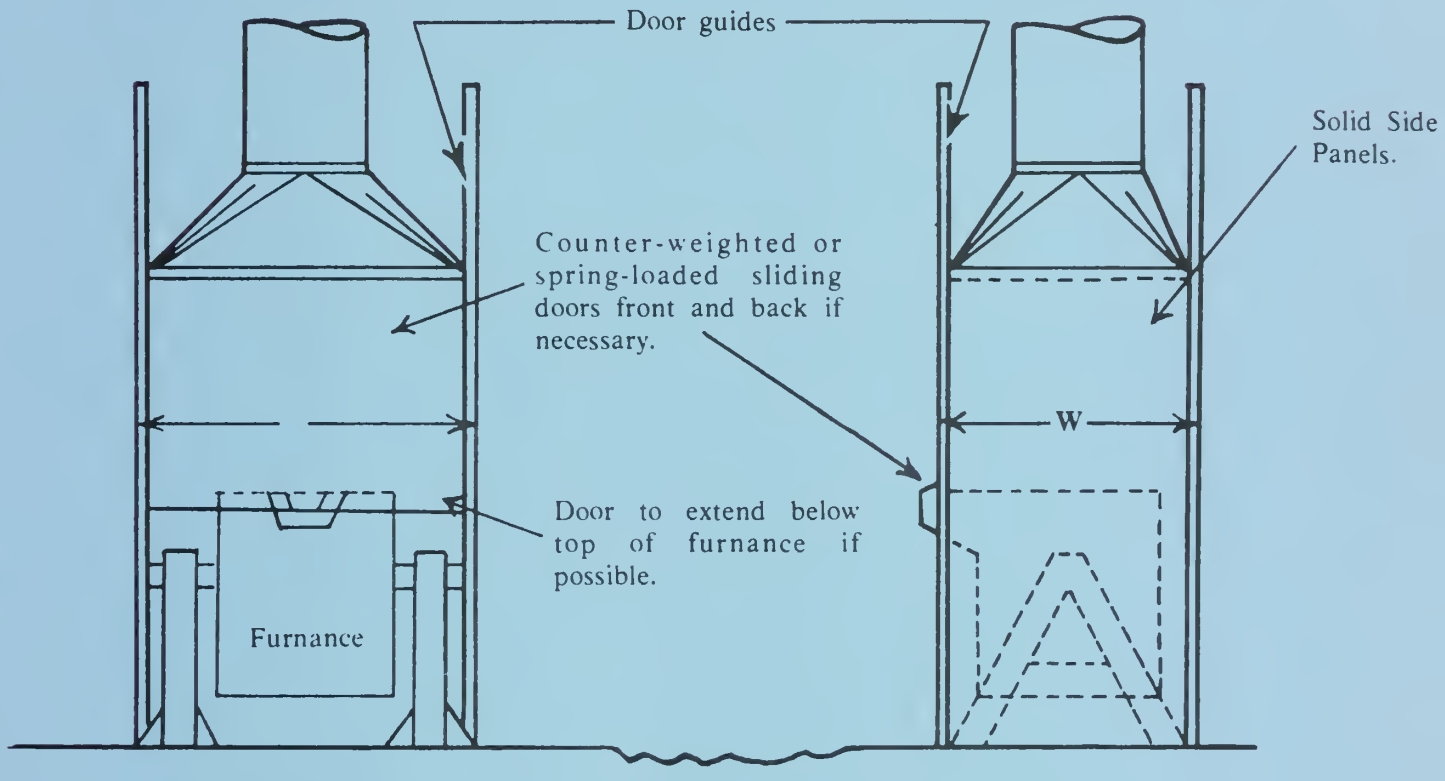
No. 1104 Supersedes No. 626 August, 1979

MELTING FURNACE "TILTING"


Door guides
Solid Side Panels.
Counter-weighted or spring-loaded sliding doors front and back if necessary.
W
Door to extend below top of furnance if possible.
Furnance

Q = 200 LW; but not less than
200 SCFM/sq. ft. of all openings with doors open.*
Entry loss = .25 VP.
Duct velocity - 2000 FPM
*Correct for Temperature and Combustion Products

NOTE: Several successful patented local enclosures, pivoted to move with the furnace, are available. Necessary air quantities are reduced with such devices.

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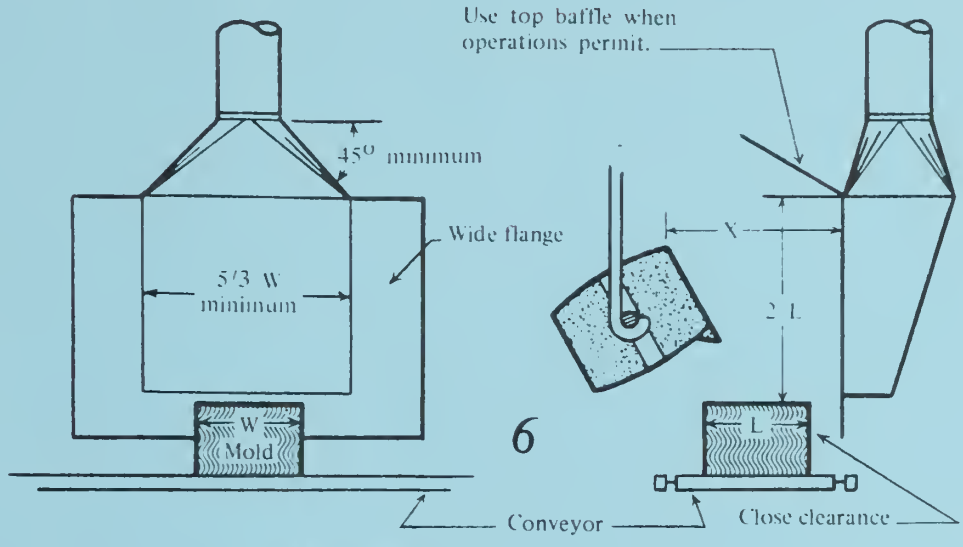
No. 1096 Supersedes No. 627 August, 1979

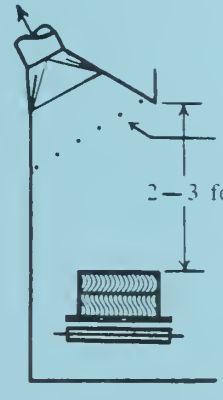
POURING STATION



SMALL MOLDS

Unflanged hood: $Q = 200 (10 X^2 + \text{Hood area})$
Flanged hood, reduce Q 25%
Duct velocity = 2,000 FPM minimum
Entry loss = 0.25VP (For slots, 1.78 slot VP + 0.25 duct VP)

Partial Side Enclosure



Q = 200 - 300 CFM/Lin. Ft. of Hood

NOTE. For large molds and ladles - provide large side - draft hood similar to shakeout
Q = 400 CFM/sq. ft. working area.

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No. 1197 Supersedes No. 1032 March, 1980

MAKE-UP AIR

GENERAL Make-up air is the supply of outdoor air to a building or space to replace air removed by exhaust ventilation and combustion processes.

When exhaust volumes are high relative to the building size and free inlet area, difficulty is encountered in inducing sufficient airflow into the building to replace the air being exhausted. Make-up air replaces the volume of exhausted air and serves to supplement general ventilation for comfort. The volume of make-up air should approximate the total volume exhausted, the flow being from clean areas to the contaminated areas.

ADVANTAGES OF MAKE-UP AIR

1. Assures that exhaust systems operate properly.
2. Assures the proper operation of natural stacks, such as combustion flues and vents.
3. Eliminates differential pressure on doors.
4. Eliminates cold drafts on workers.
5. Eliminates high velocity cross drafts through windows and doors.

A lack of make-up air creates "negative pressure" conditions which increase the resistances that the exhaust fans must overcome. This causes a reduction in exhaust volume and is particularly serious with "low pressure" fans, such as wall fans and roof exhausters.

Cross drafts not only interfere with the proper operation of exhaust ventilation, but they also disperse contaminated air from one section of the building into another. Settled material (dust) may be dislodged from beams and ledges.

CONSIDERATIONS AND APPLICATIONS The fresh air intake should be located remote from any contaminating sources, such as exhaust stacks or fan exhausts. It is advisable to filter the fresh air to protect the workers and equipment and provide maximum heat exchange efficiency if heaters are employed in the make-up air system.

The air supply system must be provided with a fan, since the exhaust fan would have to pull the air through the resistance of the filters, coils and ductwork. Otnerwise, the room would still be under a negative pressure.

Make-up air souces should be located to provide cross ventilation so that it will provide general ventilation of nuisance-producing areas and also make-up air for the exhaust systems.

Provision must be made to heat make-up air in cold weather. Occasionally, where outside dry air is preheated, a static electricity problem may exist. In such a case, moisture must be added to the incoming air to reduce or eliminate this problem.

There should be convenient "two-season" controls to afford changes in the make-up air pattern for summer and winter without closing off the delivery outlets which provide the make-up air.

Drafts from make-up air must be prevented, particularly near supply inlets. Recommended maximum inlet velocities of air not more than 10° F. below the general room temperature are:

120 fpm. for inlets less than eight feet above the floor
250 fpm. for inlets eight to 12 feet above the floor
500 fpm. for inlets 12 to 18 feet above the floor
1,000 fpm. for inlets more than 18 feet above the floor

It is recommended that the make-up air be introduced below the 12 ft. level. In this manner maximum use is made of the air from a general ventilation standpoint.

Make-up air temperatures should be maintained at approximately the same level as the desired room temperature. Since this air is being used for ventilation and replacement purposes and is not relied on for heating the building, the usual temperature range will be 65° to 80° F. If the machine or equipment heat load is a factor, lower air temperatures can be used.

MAKE-UP AIR EQUIPMENT

1. Heat exchangers using steam or hot water should be provided with nonfreeze distributed tube coils and automatic controls to minimize the possibility of freezing the heat coils during winter conditions.

2. Direct-fired units must be vented to the outside and must be provided with adequate safety controls, as specified by the American Gas Association or local and state ordinances. These units must be properly located from the standpoint of air distribution and restrictions for hazardous locations.

3. Open-flame heaters are units in which the fuel is burned directly in the make-up air stream, with no outside venting. These units must be properly located, especially where hazardous materials are involved. These units present a potential danger of carbon monoxide gas. The following additional requirements must be met:

A. The make-up air volume must be sufficient to dilute any possible carbon monoxide to less than 10 ppm.
B. Controls must stop the supply fan and close the main gas valve, in case of any flame failure.
C. Controls must interlock the make-up air unit with the exhaust fans to prevent the unit from being operated without sufficient ventilation.

.....

Much of the above information was extracted from "Industrial Ventilation," American Conference of Governmental Industrial Hygienists, and "Industrial Health Engineering," by Allen D. Brandt, Sc.D.

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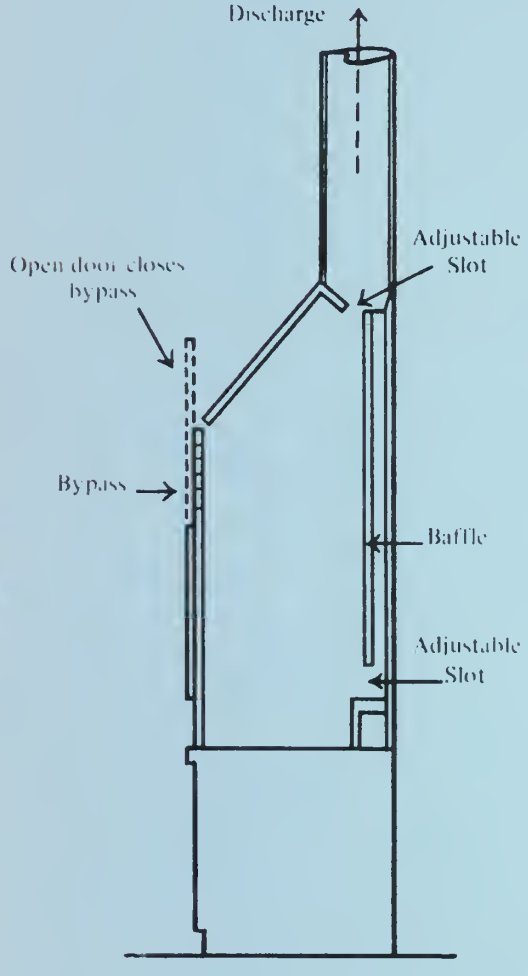
No. 1072 Supersedes No. 867 January, 1979

LABORATORY HOOD



Q = 100 to 150 CFM/sq. ft. of door or face area

Duct velocity = 1,500 to 4,000 FPM to suit conditions

Q = Airflow in cubic feet per minute

The following table can be used as a guide for determining the recommended exhaust volume for a laboratory hood.

Exhaust Volume	Contaminant
100 cfm/sq. ft. of door area	Nuisance, corrosive materials Moderate toxicity materials Tracer quantities of radioisotopes
150 cfm/sq. ft. of door area	Highly toxic materials Low M.P.C. radioactive materials
Glove Box (Dry Box) preferred (use bench hood with caution and only under ideal conditions)	Very high toxicity materials Pathogenic micro-organisms

The following points should be considered in addition to an adequate exhaust rate:

1. Distribute the exhaust evenly over the entire face of the hood.

2. Locate the hood away from interfering air currents.

3. Corrosion-resisting materials should be used where possible.

4. Locate the exhauster outside or as near outside the building as possible.

5. If radioisotopes in greater quantities than the exempt possession limits are used, an absolute filter must be employed.

6. The exhaust volume should not vary more than ±20%.

7. The airflow should be tested with an appropriate instrument at regular intervals.

The above specifications are based on information in "Industrial Ventilation," prepared by the Committee on Industrial Ventilation of the American Conference of Governmental Industrial Hygienists.

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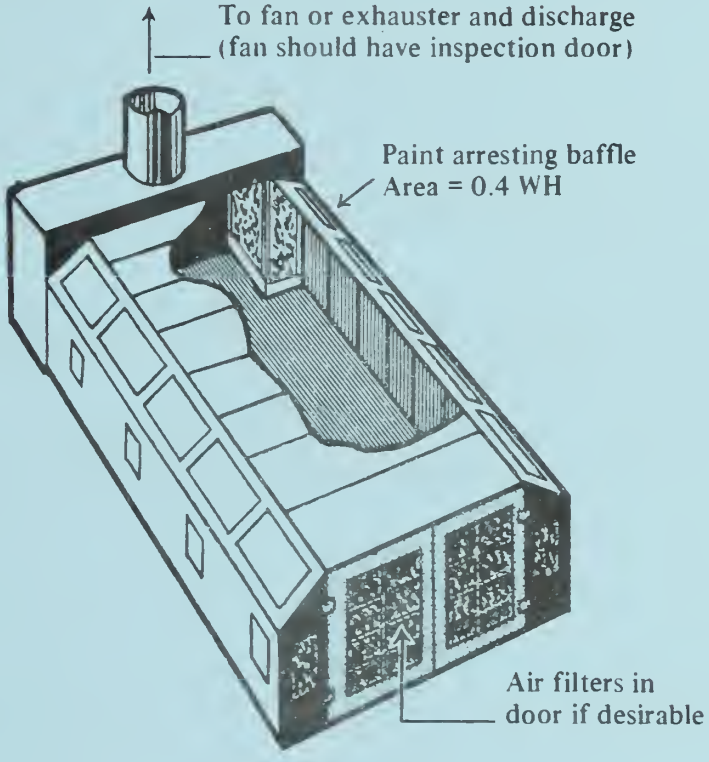
No. 1258 Supersedes No. 1194 June, 1981

SPRAY PAINTING ROOMS


To fan or exhauster and discharge
(fan should have inspection door)
Paint arresting baffle
Area = 0.4 WH
Air filters in
door if desirable

AIR VOLUME = 100 CFM/sq. ft. of cross-sectional area

ENTRY LOSS = 0.50 VP plus resistance of each filter bank when dirty

DUCT VELOCITY = 2000 FPM

AIR FILTERS = to be sized for 275 CFM/sq. ft. of filter

PAINT FILTERS = combustibility Class 2 or better

CONSTRUCTION: The design of the room must be planned to fit the work. The dimensions should be no larger than are needed to insure adequate passage of work and personnel, but should not be so small as to preclude uniform airflow through the room. The operator should be able to reach all parts of the work without finding it necessary to stand between the spray gun and the air outlet.

REQUIRED EXHAUST VOLUME: The flow rate shall be a minimum of 100 CFM/sq. ft. of cross-sectional area, except for electrostatic spraying which shall be exhaust ventilated at a minimum of 60 CFM/sq. ft. of cross-sectional area, depending upon the volume of the material being sprayed and its flammability and explosion characteristics.

RESPIRATORY PROTECTION: **The operator shall be protected against the inhalation of the "backspray" by use of a supplied air mask approved by the** U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, (NIOSH), Testing and Certification Branch (TCB).

ILLUMINATION: When spraying areas are illuminated through glass panels or other transparent materials, only fixed lighting units shall be used as a source of illumination. Panels shall effectively isolate the spraying area from the area in which the lighting unit is located, and shall be of a noncombustible material of such a nature or so protected that breakage will be unlikely. Panels shall be so arranged that the temperature of normal accumulations of residue on the exposed surface of the panel will not be raised to a dangerous level by radiation or conduction from the source of illumination.

DOWNDRAFT SPRAY PAINTING: Where a booth type enclosure is used together with downdraft design, the control velocity should be a minimum of 100 FPM or the flow rate should be 100 CFM per square foot of floor area in the booth.

MAKE-UP AIR: Clean make-up air should be supplied to the booth at a rate equal to or slightly less than that of the air exhausted.

EXHAUST FANS: These should be of sufficient capacity so that the minimum required exhaust volume is maintained when the filters are partially clogged. Many propeller fans are not designed to function against system resistances developed by a spray room system.

EXHAUST AIR DISCHARGE: **Air exhausted from spray operations shall not be recirculated. The Massachusetts Department of Environmental Quality Engineering has promulgated regulations for the discharge of exhaust air into the ambient atmosphere.**

ADVISORY SERVICE: The Division of Occupational Hygiene urges plant managers and those engaged in the erection of exhaust systems to confer with it when contemplating installation of spray painting rooms.

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No. 1318 Supersedes No. 1238 June, 1981

PLANT SHUTTLE SERVICE

EMPLOYERS ARE, BECAUSE OF THE GASOLINE AND ECOLOGY CRISES, FURNISHING "SHUTTLE" TRANSPORTATION SERVICES FOR EMPLOYEES.

THE TYPE OF VAN USED FOR THE SHUTTLE TRANSPORTATION USUALLY CAN ACCOMMODATE FOURTEEN TO SIXTEEN PEOPLE.

IT IS IMPORTANT TO KNOW THAT IF THIS TYPE SERVICE IS AVAILABLE, THERE ARE REGULATIONS WHICH ARE REQUIRED BY THE MASSACHUSETTS REGISTRY OF MOTOR VEHICLES.

1. The driver must have a Class II license.

2. The van should be equipped with a fire extinguisher, mounted, minimum size 10 BC, with a filling of dry powder.

3. A first aid box, metal Class A, equipped with those first aid items as designated by the company physician, should be mounted in an easily accessible area.

THE MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES, DIVISION OF OCCUPATION HYGIENE RECOMMENDS:

1. The company should require a pre-employment and an annual physical examination, including electrocardiogram and visual acuity evaluation, for each driver.

2. The company should request the driver to obtain his driving record from the Massachusetts Registry of Motor Vehicles to determine if the driver is a "safe" driver by evaluating the number of moving violations and other serious motor vehicle incidents which he may have had.

3. The company should require the driver to obtain first aid certification from the American Red Cross.

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No. 1117 April, 1980

INFORMATION CONCERNING PREGNANT EMPLOYEES

Massachusetts Generals Laws--Acts of 1972, Chapter 790

Massachusetts Commission Against Discrimination--Chapter 151-B, Section 3

The employee who is working full time and becomes pregnant is entitled to a minimum of eight weeks **maternity leave of absence. This time can be used either before delivery, after delivery or divided between** both. Her job or one of similar structure must be made available to her when her physician no longer considers her disabled. It is the responsibility of the employee to notify her employer of the need for maternity leave at least two weeks in advance of the period of leave.

Unemployment compensation payments are determined on an individual case-by-case basis.

1978 Amendments to Civil Rights Act of 1964

P.L. 95-555 amended Section 701 by adding subsection K. Effects of the amendment are as follows:

Requires employers to treat pregnancy and childbirth the same as other causes of disability under fringe benefit plans.

Prohibits terminating or refusing to hire or promote a woman solely because she is pregnant.

Bars mandatory leaves for pregnant women arbitrarily set as a certain time in their pregnancy and not based on their individual inability to work.

Protects the reinstatement rights of women on leave for pregnancy-related reasons, including credit for previous service and accrued retirement benefits, and accumulated seniority.

Abortion exception. The employers are not required to pay health insurance benefits for abortion, except where the life of the mother is endangered if fetus were carried to term or where medical complications have arisen from an abortion.

Effective Date - May 1, 1979

The following form is presented as a guideline for employers. The private physician of the pregnant worker should complete it as soon as the condition becomes known.

TO WHOM IT MAY CONCERN: _____ (Physician's Name)

REGARDING: _____ (Employee's Name)

It is our understanding that _____ (Employee's Name) is currently under your medical supervision for pregnancy.

It is our responsibility, both to the mother and the unborn child, to alert you to the type of work and the conditions in which she is engaged.

> A job description should follow and include the names of chemicals or gaseous substances the employee is exposed to and any other condition such as lifting, carrying, etc.

The following questions should be answered so that adequate precautions can be taken:

I believe, in light of the job description, that work can be continued in the **environment until** ____

_____

Anticipated Date of Confinement: _____

Date: _____

_____

Signature of attending physician

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No. 1254 **Supersedes No. 1126** **June, 1979**

EYE SAFETY PROGRAM

Preplacement eye examination:

Baseline Findings: Visual acuity Peripheral vision Color perception

Medical directives must be obtained from the company physician for all eye problems.

Maintain accurate records of all physical findings. Determine need for safety glasses.

If the situation permits when an eye emergency occurs, test visual acuity before any treatment is given.

SPECIFIC EYE EMERGENCIES

Protruding foreign bodies
Perforating or intraocular foreign bodies
Burns to the eye: Chemical, flash burns, caustics and alkalies
Contusions of the eye
Lacerations of the eyelid
Inflammation or infected eyes

Refer eye injuries to an ophthalmologist.

EYE INJURY TREATMENT*

A. Trauma: Apply ice compresses for 15 minutes. When eye or surrounding tissue is discolored, refer to a physician.

B. Cuts and punctures of the eye and/or surrounding tissue:

   a. Bandage lightly and refer for immediate attention.
   b. Do not irrigate eye.
   c. Do not remove object stuck in the eye.

C. Caustics, alkalies, acid in eye: Copious amounts of water irrigated gently for 20 minutes. Keep eyelids open as wide as possible.

   a. Do not use eye cup.
   b. Do not bandage the eye.
   c. Refer patient for immediate attention.

D. Foreign bodies or specks in the eye:

   a. Lift upper lid, upward and down over the lower lid.
   b. Do let eye tear.
   c. If speck is not removed, keep eye closed.
   d. Do not rub eye.
   e. Bandage lightly and refer for medical attention.

*Based and reprinted with permission from:
National Society for the Prevention of Blindness, Inc.
Massachusetts Society for the Prevention of Blindness, Inc.

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No. 1346 Supersedes No. 1125 March, 1983

EPILEPSY

DEFINITION Epilepsy is a disorder of the central nervous system in which the major symptom is a seizure resulting from temporary disturbance of brain impulses. This dysfunction is the most common organic disorder of the central nervous system.

There are three main types of epilepsy.

1. Petit mal. The individual loses consciousness, which lasts for a few seconds. The person may appear to have had only a lapse of memory. There may be twitching near the eyes and mouth. This condition is most often observed in children.

2. Grand mal. The person becomes unconscious and may experience falls, foaming at the mouth, biting of the tongue and lips, and violent shaking of the limbs (convulsion). In most cases the individual experiences a warning ("aura"), which may express itself as a visual disturbance, a ringing in the ears, or a tingling sensation of the fingers.

3. Psychomotor. The seizure is a short period of inappropriate behavior which is purposeful but irrelevant to the circumstances, e.g., a man may unknot his necktie but have no recollection of his activity when the seizure is over.

TREATMENT Anticonvulsant drugs, such as phenobarbital, Dilantin, Tridione and similar drugs, are recommended. In most instances these drugs can control seizures effectively.

NURSING CARE Prevention of injury to the patient is the primary concern. The following steps are recommended as first aid for grand mal seizures:

1. Protect the head of the patient with a pillow or improvise with padding, a blanket or similar soft material.

2. Place a padded tongue depressor between the upper and lower jaws.

3. During a seizure, keep the patient in a position to prevent aspiration of vomitus, e.g., on side or with torso elevated, not flat on back.

4. DO NOT use restraint of any nature.

5. After consciousness is regained, the patient should be allowed to sleep if he so wishes.

6. Determine whether the patient has a past history of seizures, a diagnosis of epilepsy, and/or prescribed medications. Seizures are a nonspecific symptom of brain disturbance; hence the first appearance of seizures must be carefully evaluated by a physician. Solvent fumes and other intoxicant exposures are one possible cause of seizures.

7. Determine if the medication prescribed has been taken.

8. Determine if the employee has had any unusual emotional stress preceding the seizure.

9. Report observations to the patient's physician.

Note: No measures are usually required for petit mal or psychomotor seizures.

EMPLOYMENT Persons with epilepsy are usually extremely conscientious workers. Proper job placement involves thorough medical knowledge of the individual worker's seizure pattern, i.e., the degree of control, type and frequency of seizure in particular.

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No. 1127 June, 1979

EMERGENCY MEDICAL TRANSPORTATION

911 EMERGENCY TELEPHONE NUMBER 911
[UNIVERSAL FOR THE ENTIRE COMMONWEALTH OF MASSACHUSETTS]

In the event that a State Region has not completed the Emergency Medical Transportation program, telephone the local Police Department.

PROCEDURE

1. Identify the location where the emergency problem exists.

2. Give adequate information for the telephone screening.

   Sex and approximate age of victim

   Vital Signs:

   Pulse: Quality, rate, rhythm
   Respirations: Quality, rate, rhythm
   Skin condition: Cyanotic, color, moist
   Blood pressure

INJURY:

Type of injury
Bleeding control--location
Cause of injury
State of consciousness

ILLNESS:

Pain: location, severity
Exposure to toxic substance: Type: Inhalation
Ingestion
Absorption
State of consciousness

THE DISPATCHER AT TELEPHONE NUMBER 911 will send the appropriate vehicle(s) for the emergency situation.

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
William M. Shipps, **COMMISSIONER**

DIVISION OF OCCUPATIONAL HYGIENE
Leonard D. Pagnotto, C.I.H., **DIRECTOR**

39 Boylston Street, Boston 02116

Telephone 617/727-3982

No. 1293 Supersedes No. 1131 December, 1982

RECOMMENDED FIRST AID SUPPLIES

A. At least one centrally located dustproof First Aid box, large enough so that each article therein is in plain view and easily accessible, and containing as a minimum:

1. A standard First Aid text-book or manual, such as that of the American Red Cross or the U.S. Bureau of Mines.

2. Instruments consisting of:
   a. Bandage scissors,
   b. Assorted safety pins,
   c. Tongue depressors,
   d. Cotton-tipped applicators,
   e. Tweezers,
   f. Enamel basin,
   g. Thermometers,
   h. Ambu or Hope type resuscitator.

3. Drugs consisting at least of:
   a. Ammonia inhalants (pearls), or sterile inhalant ammonia pads,
   b. Any recognized fluid skin antiseptic, except preparations containing iodine or phenol (carbolic acid),
   c. Eye irrigation solution, clean, preferably single-use and sterile,
   d. Six pressure bandages - (2-3-4-6 inches in width).

4. Dressings, in adequate quantities, consisting at least of:
   a. Adhesive dressings, individually wrapped,
   b. Adhesive tape rolls, 1-inch wide,
   c. 1-inch gauze bandage rolls,
   d. Sterile gauze pads, 2-inch square,
   e. 2-inch gauze bandage rolls,
   f. Sterile gauze pads, 4-inch square,
   g. 4-inch gauze bandage rolls,
   h. Absorbent cotton packages,
   i. Triangular bandages - minimum 3,
   j. Splints of assorted sizes and splint padding rolls, preferably air type,
   k. Disposable ice packs - various sizes.

B. The First Aid box must be in charge of and maintained regularly by an employee who:
1. Holds an American Red Cross Standard First Aid Certificate, or its equivalent, and

2. Works in the immediate vicinity of the box.

C. The Red Cross or other certificate mentioned above should be prominently displayed in the vicinity of the main First Aid box.

D. Appropriate record forms should be kept according to federal and state regulations

E. Furnishings consisting at least of:

1. A stretcher, portable,

2. One blanket, one sheet, and one pillow.

F. Additional instruments, drugs, dressings, supplies, furnishings, and procedures as selected by a company-authorized licensed physician. List the non-prescription drugs.

_____

DOCTOR'S NAME

_____

DATE

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
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No. 1252 Supersedes No. 1135 March, 1981

It is recommended for medical-legal purposes that an accurate record of all first aid treatment be written down in ink. This bulletin is issued as a guideline for all treatment given to employees.

FIRST AID LOG

MONTH: YEAR:

DATE	TIME	DEPT.	NAME	HISTORY OF ACCIDENT OR ILLNESS	TREATMENT	OCC.	NON OCC.	DISPOSITION			SIGNATURE OF FIRST AIDER
								RTW	DR	HOME	

DEPARTMENT OF LABOR AND INDUSTRIES - William M. Shipps, COMMISSIONER
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Supersedes No. 1137

No. 1241 January, 1982

HEARING CONSERVATION

The hearing conservation program, to be truly effective, must contain the following six basic procedures:

1. Education and indoctrination of all employees who participate in the program.
2. Evaluation of noise hazards and areas where they occur.
3. Monitoring and audiometric testing.
4. Noise control at the source and individual ear protection.
5. Accurate record keeping.
6. Case disposition of individual employees.

The following questions are suggested for new and currently employed personnel who may be exposed to high noise levels.

PERSONAL HISTORY

1. Have you had a cold or upper respiratory infection recently?
2. Do you take medication, particularly of a type with a salicylate base, such as aspirin or similar compounds, cold tablets or seltzer products? If so, when, how frequently and when did you take it last?
3. Have you ever had any ear infections or ear operations?
4. Have you any sinus problems?
5. Have you ever been exposed to excessive noise in your former places of employment?
6. Are you right or left handed?

SERVICE IN THE ARMED FORCES

1. Have you been in the Armed Forces?
2. Have you been in the National Guard?
3. What were your duties in the service?
4. How long and how frequently were you on the firing range?

HOBBIES, SPORT PARTICIPATION AND RECREATION

Do your activities include these diversions?

Scuba Diving _____
Sky Diving _____
Piloting a plane _____
Riding a motorcycle or snowmobile _____
Hunting, Skeet Shooting, Target Practicing _____
Listening to stereo and wearing "muffs," or rock and roll music _____
Working with power tools at home _____
Playing a musical instrument, such as percussion or wind instruments _____

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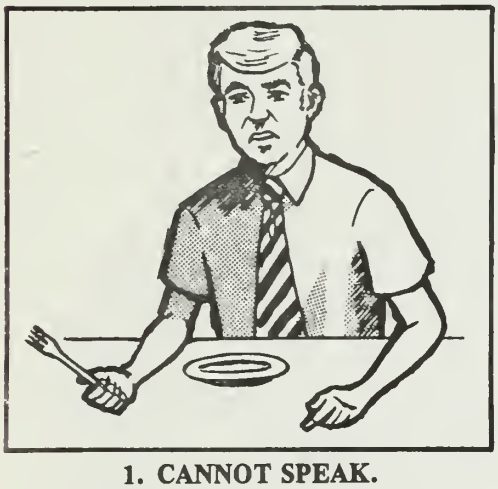
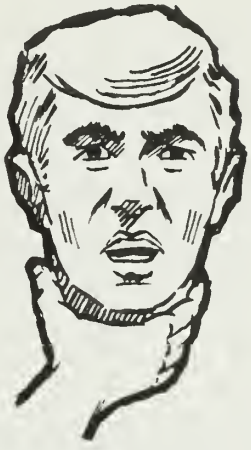
No. 1202 Supersedes No. 1035 January, 1980

HEIMLICH METHOD OF RESUSCITATION

Foreign bodies which become lodged in the throat after two minutes or longer can cause brain injury and/or death due to strangulation. In this emergency such symptoms as inability to speak, blue skin color (cyanosis), glassiness of eyes and loss of consciousness may occur.



1. CANNOT SPEAK.

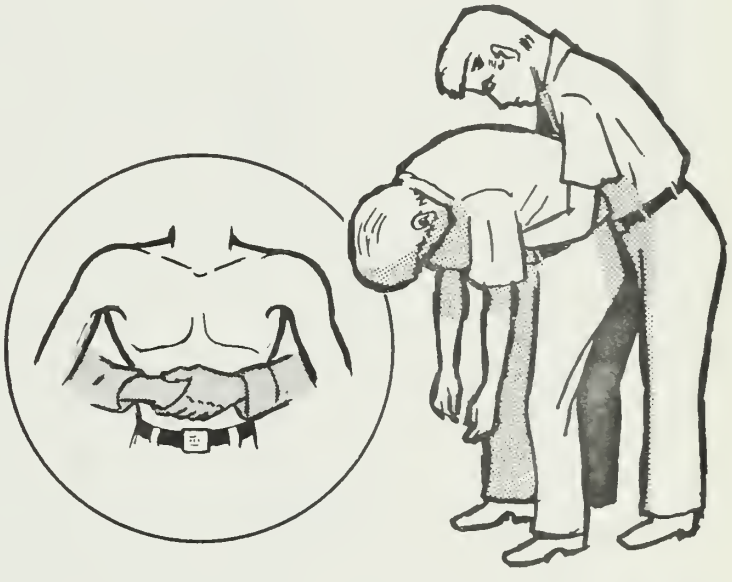


2. TURNS BLUE

3. COLLAPSES.

The Heimlich method for this seizure is recognized as a most effective procedure in treating a patient on the verge of choking. The steps to be applied are as follows:

1. The attendant should stand behind the victim, who may be in a sitting or standing position.
2. The attendant should wrap his or her arms around the victim's waist, make a fist and grasp it with hisor her other hand.
3. The tightly-grasped fist should be then pressed against the victim's abdomen, between the bottom of the rib cage and the navel, and a quick upward thrust applied.



4. Step No. 3 should be repeated if necessary.
5. The patient should be referred to a physician for medical evaluation.

The diagrams illustrate the above-mentioned positions.

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
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No. 1145 April, 1983

RECOMMENDED SAFE PRACTICES

NURSING DATA SHEET NO. 10

OCCUPATION/WORK HISTORY

Name _____ Address _____ Soc. Sec. No. _____

Date Employed _____ Occupation _____ Department _____

Date of Placement Examination _____

Name of Company (Last employer first)	Dates Employed	Job Description	Duties	Exposures to Dust, Solvents and Vapors

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF LABOR AND INDUSTRIES - William M. Shipps, COMMISSIONER
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No. 1154

March, 1981

COLOR CODING

"Color Coding" is a phrase used by Occupational Health Nurses.

The "color coding" procedure is used to indicate specific medical problems of the employees. The color code is placed on the individual medical folder either by the use of color marking pencils or various colored tabs.

The color code index is posted on the medical history filing cabinets for quick and easy reference.

The following chronic diseases and related medical problems are usually coded:

1. Red - Allergy, including specific drug sensitivity
2. Blue - Heart or circulatory problems, including hypertension
3. Green - Diabetes mellitus
4. Orange - Epilepsy and related conditions
5. Purple - Specific Appliances

   A. Yellow - Contact Lenses
   B. Brown - Prosthetic or Orthopedic Appliances

The list could be tailored to the specific need of the medical department.

The value of color coding on the individual medical folders is twofold:

1. The Occupational Health Nurse is immediately alerted to a chronic condition or medical problem if an employee becomes ill or injured.

2. A relief nurse or a newly hired nurse will become aware of the health problems of the employees.

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
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No. 1245 Supersedes No. 1018 July, 1980

MASSACHUSETTS POISON CONTROL SYSTEM

The Massachusetts Poison Control system is an organized state-wide approach to the management of toxic substance exposure. The single Poison Information Center is located at Children's Hospital Medical Center, 300 Longwood Avenue, Boston, Massachusetts 02115.

Emergency Telephone Numbers

24 HOURS A DAY--7 DAYS A WEEK
TOLL FREE NUMBER 1 - 800 - 682 - 9211
METROPOLITAN BOSTON NUMBER 617 - 232 - 2120

The Information Center has multiple responsibilities. It provides emergency consultation on poisonings and assists in the transfer of appropriate patients to medical facilities. It also makes available educational materials to the public and to professionals.

The Center also provides a broad range of knowledge through its consultants--environmental and industrial toxicologists at Harvard School of Public Health and Massachusetts Institute of Technology.

The staff of the Center includes the director, a pediatrician/clinical toxicologist; the assistant director, a doctor of pharmacy trained in clinical toxicology; 12 pharmacists and nurses who serve as information specialists; the editor of "Clinical Toxicology Review," a physician/clinical toxicologist; and the coordinator of the System's computer program. The information specialists work full time and are trained to provide information about diagnosis and treatment of drug overdose and poison prevention.

The information Center uses extensive information-retrieval capabilities to facilitate its work. These include a microfiche system, an online computer to a data bank at the National Clearinghouse for Poison Control in Washington, National Clearinghouse card files, journals and texts in toxicology, pharmacology, and medicine toxicology reprint files, a registry of hospitalized cases and computerized case files. All sources are up to date and readily accessible for information and education purposes.

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
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No. 1287 Supersedes No. 1203 March, 1980

SERVICES AVAILABLE FOR HEALTH AND EDUCATIONAL MATERIAL

The following organizations have pamphlets, publications and films available for health education and information.

Voluntary Agencies

Alexander Graham Bell Association
for the Deaf
3417 Volta Place, NW
Washington, DC 20007

American Cancer Society, Inc.
4 West 35th Street
New York, NY 10001

American Diabetes Association, Inc.
2 Park Avenue
New York, NY 10016

American Foundation for the Blind
15 West 16th Street
New York, NY 10011

American Heart Association, Inc.
2233 Wisconsin Avenue, NW
Washington, DC 20007

American Lung Association
1740 Broadway
New York, NY 10019

American Red Cross
17th Street Between D and E Streets, NW
Washington, DC 20006

American Rehabilitation Counseling
Association
5999 Stevenson Avenue
Alexandria, VA 22304

Arthritis Foundation
115 East 18th Street
New York, NY 10003

Epilepsy Foundation of America
4351 Garden City Drive
Landover, MD 20785

Maternity Center Association
48 East 92nd Street
New York, NY 10028

Muscular Dystrophy Association, Inc.
810 Seventh Avenue
New York, NY 10019

National Multiple Sclerosis Society
205 East 42nd Street
New York, NY 10017

National Society to Prevent Blindness
79 Madison Avenue
New York, NY 10016

Planned Parenthood Federation of
America, Inc.
810 Seventh Avenue
New York, NY 10019

United Cerebral Palsy Associates
2400 East Devon Avenue
Des Plaines, IL 60018

Professional and Technical Agencies

American Association of Occupational
Health Nurses (AAOHN)
3500 Piedmont Road, NE
Atlanta, GA 30305

American Dental Association
211 East Chicago Avenue
Chicago, IL 60611

American Industrial Hygiene Association
475 Wolf Ledges Parkway
Akron, OH 44311

American Medical Association
535 North Dearborn Street
Chicago, IL 60610

American Nurses Association Headquarters
2420 Pershing Road
Kansas City, MO 64108

American Occupational Medical
Association
2340 South Arlington Heights Road
Arlington Heights, IL 60005

(Continued)

Professional and Technical Agencies (Continued)

National Education Association
1201 16th Street,NW
Washington, DC 20036

National League for Nursing, Inc.
10 Columbus Circle
New York, NY 10019

National Health Council
70 West 40th Street
New York, NY 10018

National Safety Council
444 North Michigan Avenue
Chicago, IL 60611

Commercial and Business Groups

American Can Company
American Lane
Greenwich, CT 06836

Equitable Life Assurance Society
of the United States
1285 Avenue of the Americas
New York, NY 10009

Borden, Inc.
277 Park Avenue
New York, NY 10017

General Mills, Inc.
9200 Wayzata Boulevard
Minneapolis, MN 55440

Bristol-Myers Company
345 Park Avenue
New York, NY 10003

John Hancock Mutual Insurance Company
John Hancock Place
Boston, MA 02117

Metropolitan Life Insurance Company
One Madison Avenue
New York, NY 10010

Governmental Agencies

U. S. Department of Health and Human Services
National Institute for Occupational Safety
and Health (NIOSH)
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati, OH 45226

U. S. Department of Labor
Occupational Safety and Health
Administration (OSHA)
200 Constitution Avenue, NW
Washington, DC 20210

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES

George W. Ripley, COMMISSIONER

Division of Occupational Hygiene

Richard Levine, DIRECTOR

1001 Watertown Street, West Newton 02165

Telephone: 617/969-7177

No. 1376 Supersedes No. 1365 April, 1986

GUIDELINES FOR INFORMING EMPLOYEES OF MEDICAL AND/OR LABORATORY FINDINGS

Employees should be informed about the medical findings when examinations are made for exposures in the occupational environment which may be hazardous to the health of the worker. These findings would be determined from physical examination, audiometric testing, laboratory procedures, X-ray, and vital capacity testing.

When an employee is informed of test results, it is suggested that a signed statement should be obtained by the employer indicating that the employee has been made aware of the findings. The following form is submitted as a guide for this procedure.

Date_____

Dear _____:
Name of employee

_____, completed on _____ was:
Name of test or procedure Date

a. Within normal limits_____

b. Is to be repeated _____ _____
Date

c. Report to Doctor_____ for further evaluation.

.....

The medical findings of the above-mentioned procedure have been discussed with me. I am fully aware of the findings.

_____
Signature of employee

_____
Signature of witness

_____
Date

The signed form should be retained in the medical folder of the employee.

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
William M. Shipps, COMMISSIONER

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No. 1205 December, 1982

RECOMMENDED SAFE PRACTICES

NURSING DATA SHEET NO. 15

FIRST AID MONTHLY SUMMARY

MONTH: YEAR:

DEPT.	OCCUPATIONAL										NON-OCCUPATIONAL										SUMMARY			
	BURNS	DERMATITIS	EYE INJURIES	FRACTURES	SPLINTERS	SPRAINS	STRAINS	WOUNDS-CUTS	OTHER		NEW CASES	REVISITS	TOTAL VISITS	DYSMENORRHEA	G.I.	HEADACHE	INJURY	RESPIRATORY	UPSET STOMACH	OTHER	NEW CASES	REVISITS	TOTAL VISITS	TOTAL VISITS	DISPOSITION: RTW	DOCTOR	HOME	REMARKS

DEPARTMENT OF LABOR AND INDUSTRIES
DIVISION OF OCCUPATIONAL HYGIENE
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No. 1226

June, 1981

HISTORY OF MASSACHUSETTS ASBESTOS COMMISSION

In recognition of the fact that the use of asbestos in public buildings and schools is a potential health hazard, a special legislative commission was established under Chapter 58 of the Resolves of 1975, and was subsequently revived by Chapter 3, of The Resolves of 1980, to investigate and evaluate the extent of asbestos exposure in the public schools and public buildings of Massachusetts.

The special commission consists of two members of the Senate, three members of the House of Representatives and nine persons appointed by the Governor, including the Commissioner of Public Health, the Director of the Division of Occupational Hygiene and related experts in asbestos-related fields, two physicians, an architect, a construction engineer, a structural engineer, an environmental health scientist and a chemist.

The mandate for the Asbestos Commission was to "evaluate the extent of the use of asbestos as fireproofing in the public schools and public buildings of the Commonwealth and its containment and removal." The Commission was provided with an operating budget of $50,000., which was used to hire technical staff for the Commission. The program was confined to an investigation of asbestos in public schools, and the scope of the project was limited to "spray-on" coatings under the assumption that it was this type of material and its use which had the greatest potential for generating airborne asbestos fibers.

Since 1977, the first year the Massachusetts Asbestos Commission was funded, the Commission has made some very significant accomplishments.

All public schools built between 1946 and 1973 have been surveyed for spray-on asbestos uses. Many hazardous conditions in these schools have been identified. The Asbestos Commission has made recommendations to alleviate the asbestos hazard. Some of these recommendations have been carried out. Other schools have not yet acted.

The Asbestos Commission is presently conducting asbestos surveys of public buildings in the state. The Commission has identified many asbestos-containing spray-on ceilings in these buildings. In addition, the presence of friable asbestos pipe and boiler insulation has been confirmed in nearly 100% of these public buildings. No official recommendations have yet been made in these cases.

Further survey work and recommendations will be made provided project funding is available.

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
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No. 1338 Supersedes No. 1308 March, 1982

WILLIAM M. SHIPPS
Commissioner

The Commonwealth of Massachusetts
Executive Office of Economic Affairs
Department of Labor and Industries
Division of Occupational Hygiene
39 Boylston Street, Boston 02116

PROTOCOL FOR INVESTIGATING BAD AIR COMPLAINTS

1. Check for chemical exposure sources

2. Test Ventilation System

   (a) Determine total air supplied to room CFM. Measure air flow through ceiling diffusers or air supply ducts.

   (b) Estimate space volume of room

   (c) Using (a) and (b) calculate air changes per hour

   (d) Determine percent of fresh air introduced in room or system (usually determined by checking design plans or checking with firm that installed ventilation

   (e) Check location of fresh air intakes on outside of building (street level intakes may be near parking lot or busy street)

3. Symptoms of occupants

   (a) Record type and frequency

   (b) Look for patterns

4. Test for

   (a) Carbon dioxide - levels above 500 ppm casts doubt about the adequacy of the ventilation system

   (b) Carbon monoxide - should be less than 2 ppm

   (c) Particulate matter (usually observation is necessary)

   (d) Total hydrocarbons - use combustible gas meter. Should be negative.

   (e) Formaldehyde - should be less than 0.1 ppm

   (f) Nitrogen dioxide - should be negative

4. Record

(a) Temperature - office room air usually in range of 65 - 80°F

(b) Relative humidity - usually 40-60%

CRITERIA RECOMMENDED
BY
MASSACHUSETTS DIVISION OF OCCUPATIONAL HYGIENE

Air Changes per Hour	Fresh Outside Air - CFM per Occupant	Percentage of Fresh Outside Air
Minimum of 6, but 10 preferred	Minimum of 15 CFM, but 25 CFM preferred where no smoking is permitted. Minimum of 35 CFM where smoking is permitted	Minimum of 15% but 25% preferred

B-2 Schoolhouse Structural Standards - Rules and Regulations of Department of Public Safety. These standards were incorporated into the Massachusetts Building Code, January 1, 1975. The code was modified several times and in September, 1980, revised ventilation requirements are addressed only by reference to the BOCA Code in the Appendix. The B-2 Standards are still applicable to schools built or in the design stage prior to 1975.

According to the B-2 Regulations, all classrooms shall be provided with a minimum of 24 CFM of air per student. This air shall consist of a minimum of 10 CFM fresh air. Other rules concerning ventilation of special places such as lunchrooms, auditoriums, gymnasiums, etc., are found in the regulations.

The BOCA Code provides for a minimum of 5 CFM air per occupant (if filtration is provided) and allows up to 85% recirculated air. The minimum fresh air requirement also depends on occupancy classification.

Leonard D. Pagnotto, C.I.H.
Director
Mass. Department of Labor and Industries
Division of Occupational Hygiene

SAFE REPAIR PRACTICES OF ASBESTOS PIPE AND BOILER COVERINGS

This bulletin discusses certain uses of asbestos in boiler and mechanical rooms, and indicates recommendations to reduce the potential hazards from this asbestos.

Asbestos has been used as fire and thermal insulation and may be found in the following locations:

1. Covering the boiler, furnace or hot water tank.

2. Covering steam pipes throughout the building.

3. On the ceilings of the boiler and mechanical rooms.

The potential hazard arises when asbestos fibers become airborne and can subsequently enter the respiratory system. If the asbestos-containing material is in good condition and firmly bound, the asbestos fibers cannot be released into the ambient air.

It is important to note that the Asbestos Program does not recommend the removal of asbestos pipe or boiler coverings unless the material is in irreparable condition. In most cases, the material can be repaired to prevent fiber release. The following recommendations are presented to develop an effective safe repair program:

1. Inspect asbestos pipe and boiler coverings regularly. Look for holes, cracks, tears, flaking and chalking.

2. For minor rips and tears in the asbestos pipe covering, duct tape may be used as a temporary method of repair. However, duct tape tends to dry out, especially in high temperature locations, such as boiler rooms. More permanent enclosures include rewettable fiberglass cloth, PVC jackets, or metal/aluminum sleevings.

3. For holes and tears in boiler or furnace coverings, thoroughly wet damaged areas, carefully remove any loose debris, and then patch with a non-asbestos patching material.

4. Asbestos pipe coverings should be painted with a latex-base paint with appropriate fire rating.

5. Where surfaces such as pipe coverings are accessible to damage by building occupants, there should be mechanical enclosures to prevent punctures and the generation of dusts.

6. NIOSH approved dust respirators should be worn for all asbestos related work.

7. Disposable coveralls should be worn for repair and removal work.

8. All clean up of asbestos or asbestos contaminated materials should be done by wet methods, i.e., sponging or mopping. There should be no dry sweeping or vacuuming.

When the asbestos-containing material is beyond repair, it should be removed. It should also be removed if it is in areas where it will be damaged repeatedly. In addition, it is often necessary to remove the material in order to repair or replace part of the heating system. If removal is required, additional precautions must be taken:

1. The work area should be isolated from the rest of the building by a double sheeting of polyethylene to form an air-tight enclosure during removal or extensive repair of asbestos pipe lagging.

2. Asbestos waste should be bagged and disposed of in an approved land fill. Further information on proper disposal of asbestos waste can be obtained from the Department of Environmental Quality Engineering.

This office should be notified before starting any work on the asbestos-containing material to ensure that the proper precautions are being adhered to. If repair work is to be performed, maintenance personnel should take these necessary precautions to protect themselves and the occupants of the building.

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
William M. Shipps, Commissioner

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No. 1348 Supersedes No. 1311 March 1983

The Commonwealth of Massachusetts

Executive Office of Labor

Department of Labor and Industries

Division of Occupational Hygiene

39 Boylston Street, Boston 02116

SUGGESTED BID SPECIFICATIONS

FOR CONTRACTUAL ASBESTOS RELATED WORK

REFERENCE: Mineral Safe Practices Data Sheet #2, "Asbestos".

Introduction: The purchaser of contract services is advised to establish controls to minimize asbestos exposure to prevent building contamination and to protect building occupants. Once the contractor leaves the job site there are currently no regulations protecting the building owners. To ensure proper clean-up performance by the contractor, the purchaser of the contract services should provide the contractor with definitive job specifications for asbestos related work. Such specifications essentially restrict bidding to those contractors who know the work and regulations, and are prepared to do a thorough job. The written contract should detail work activities which comply with EPA, OSHA and Mass. Department of Labor & Industries regulations. In addition, bonding is desirable to insure appropriate compliance with the contract and completion within the scheduled time period. Before the asbestos related work commences, a pre-bid meeting should be attended by all key project personnel. The following are suggested specifications which should be included in the contract for the proposed asbestos work:

SUGGESTED SPECIFICATIONS FOR PROPOSED ASBESTOS WORK

Applicable Regulations: The contractor shall comply with EPA and OSHA regulations for work practices involving the handling, renovation and/or removal of asbestos containing material. The following publications are applicable:

(1) Occupational Safety and Health Standards (29 CFR 1910) in general, and specifically Section 1910.1001.

(2) Environmental Protection Agency regulations contained in Title 40 (CFR Part 61, Subpart B, as amended, as applicable to asbestos).

(3) Mass. Dept. of Labor, Industrial Safety Bulletins Nos. 1, 2, 12 and 13.

Notification: The contractor shall notify the Massachusetts Department of Labor and Industries, Division of Occupational Hygiene ten (10) days in advance of the commencement of the work project. The contractor shall notify the Massachusetts Department of Environmental Quality Engineering, Division of Air

Publication approved by John J. Manton, State Purchasing Agent - #13184-6-1000-4-83-CR

and Hazardous Materials, twenty (20) days in advance of the commencement of the work, and the Federal Environmental Protection Agency ten (10) days in advance.

Permits: It is the responsibility of the contractor to secure all the necessary permits for the asbestos related work, including hauling, removal, and disposal. The contractor is also responsible for timely notification of such actions, as may be required by the Federal, State, regional, and local authorities. Matters of interpretation of these standards shall be submitted by the contractor to the respective administrative agency for resolution before starting the job.

Submittals: The purchaser will specify the time table necessary for the operation to proceed smoothly and be completed in a reasonable period. The contractor will then submit a detailed construction schedule describing the phasing, sequencing and interfacing of all the trades involved in the asbestos related work. The construction schedule, and compliance with its dates is mandatory.

Worker Protection:

(1) Equipment: The contractor shall furnish all the equipment, tools, and special clothing necessary to perform the work in a safe and expeditious manner. Power equipment shall conform to OSHA standards.

(2) Clothing: Workers shall wear special whole body clothing, head and foot coverings. Asbestos contaminated clothing shall be disposed of as an asbestos waste product, or a special procedure may be followed to launder them, (29 CFR 1910.1001). Eye protection and hard hats shall be provided as appropriate. All disposable clothing must be fire retardant.

(3) Respirators: Workers are to be provided with respiratory equipment. The respirators are to be sanitized and maintained according to the manufacturer's specifications. Appropriate respirator selection is dependent upon the intensity of the asbestos exposure. OSHA guidelines for respirator selection are outlined below:

(a) An air purifying respirator is to be used when the 8-hour TWA is not more than 20 fibers per cubic centimeter of air

(b) Powered air purifying respirators are to be used when the 8-hour TWA is greater than 20 fibers, but less than 200 fibers per cubic centimeter of air.

(c) A type "C" continuous flow or pressure-demand supplied air respirator is to be used when the 8-hour TWA is greater than 200 fibers per cubic centimeter of air.

Note: Respirators may be used for exposures lower than their rated protection.

Medical: Medical examinations must be performed and medical records kept in accordance with OSHA regulations and made available to the Department of Labor and Industries. In addition, the contractor shall furnish written proof that employees have had instruction on the hazards of asbestos exposure, on the respirator use, decontamination and OSHA regulations.

Personal Hygiene: All workers without exception:

(1) Will change work clothes at designated areas prior to starting the day's work. Separate lockers or acceptable substitutes will be provided by the contractor for street and work clothes.

(2) All work clothes shall be removed in the work access area prior to the departure from this area. Workers will then proceed to the showers. Workers will shower at the end of each work day. Hot water, towels, soap, and hygienic conditions are the responsibility of the contractor.

(3) No smoking, eating or drinking is to take place beyond the established clean room at the work site. Prior to smoking, eating, or drinking, workers will be fully decontaminated. Each worker will then dress in clean coveralls to eat, drink, or smoke. These new coveralls can then be worn back onto the work area.

(4) Work footwear will remain inside the change area until the completion of the job, and then disposed as asbestos waste or thoroughly cleaned.

Security Program:

(1) The building must be closed to the public. A security system must be established so that only authorized personnel can enter the asbestos job site.

(2) Caution signs are to be posted at all work locations. These signs must conform to OSHA regulations. (29 CFR 1910.1001).

(3) A security guard is to be stationed at the entrance to the building.

(4) Emergency exits shall be maintained, or alternate exits provided, during construction.

Work Procedures and Practices:

(1) The purchaser of the contract services and the contractor should inspect the present condition of the walls, floors, ceiling, and other fixtures in the work area. The contractor is responsible for any damage that occurs as a result of the asbestos related work project. Pictures may be desirable.

(2) Isolation of the work area ventilation system is carried out first to prevent contamination and fiber dispersal to other areas of the building during the work phase.

(3) All moveable objects present in the proposed work area must be transferred to a new location outside the proposed work area. Anything remaining in the work area must then be sealed with polyethylene sheeting.

(4) The asbestos work area must be isolated from the rest of the building, and access restricted to the site according to OSHA regulations. This is accomplished by sealing corridors and entry ways with polyethylene plastic barriers.

(5) Setting up the Enclosures:

A major effort must be undertaken to ensure that the asbestos fibers are confined at the work site and that all surfaces are free of asbestos accumulation when the work is completed. This is accomplished by creating a series of four specially designed chambers:

(i) Work Space: The handling, renovation and/or removal of asbestos must be confined to this space. All surfaces (excluding the asbestos-containing materialitself) must be protected from contamination with polyethylene sheets of 6 mil or greater thickness. All edges must be taped securely. All walls, floors, furnishings, diffusers, grilles and air conditioning units must be covered and sealed. All workers must remove gross contamination from their clothing before leaving this area.

(ii) Equipment and Access Area: This area is designated for equipment storage and access to the work space. Workers must remove all protective clothing, except for their respirators in this area. All surfaces shall be covered with polyethylene as described for the work space.

(iii) Shower Room: Workers will remove respirators and shower in this area.

(iv) Clean Room: This area is to be kept free from asbestos contamination. All street clothes must be kept in the confines of this space. At the beginning of the work cycle, workers will change into clean protective clothing in this area. At the end of the work cycle, workers dress in this area after showering.

(6) If, at any time, air monitoring shows that areas outside the sealed plastic enclosures have 8-hour TWA's above the background level of 0.04 fibers/cc, these contaminated areas must be enclosed. They will then have to be maintained and cleaned in the same manner as the work space.

(7) Removal of ceiling mounted objects such as lights, partitions, and other fixtures must precede the actual asbestos related work. This will usually result in contact with ceiling, creating potentially hazardous asbestos exposures. Localized water spraying during fixture removal must be used to reduce fiber dispersal. Protective clothing and an air purifying respirator must be worn.

(8) Before asbestos material is handled, it must be sprayed with water containing a wetting agent to prevent excessive dispersal of asbestos fibers. The asbestos material should be wetted repeatedly during the work process to minimize asbestos fiber dispersion.

(9) In work projects that require a great deal of water for wetting the asbestos-containing material, 24 volt safety lighting must be used in lieu of the building's own lighting system.

(10) All asbestos and asbestos-contaminated waste material shall be sealed in polyethylene plastic bags with a thickness of 6 mil or greater. The bags are to be labelled, transported and disposed of in accordance with the applicable OSHA and EPA regulations. At the conclusion of the job, all polyethylene material, tape, cleaning material, and clothing will be bagged and treated as asbestos waste.

(11) All equipment including plywood, scaffolding and planks will be cleaned of asbestos material prior to leaving the work area.

Air Monitoring: Air sampling must be conducted during related asbestos work and and cleaning phase to ensure that the contractor is complying with all codes, regulations and ordinances. The sampling methods to be used at the job site are described in OSHA 1910.

All air monitoring must be in compliance with the NIOSH approved method for asbestos sampling. Air monitoring will be performed to provide the following samples during the period of the asbestos related work:

Suggested sampling:

Area to be Sampled	Number of Samples	Minimum Sample Volume in Liters
Workers	1/120 man hours with a minimum of one	As appropriate
Outside work area barriers	Average of one per day with a minimum of two per job	1000

These samples will be used to determine worker exposure to asbestos for the purpose of selecting the appropriate respirator. They will also be used to determine if the asbestos material has been successfully contained in the work area, or if additional sealed enclosures need to be constructed to contain the material.

Clean-Up:

(1) When the work is finished, it is the contractor's responsibility to clean the area to a safe level.

(2) All debris shall be cleaned up and deposited in the bags designated for asbestos waste.

(3) All surfaces shall be wet mopped.

(4) The area shall be cleaned by wet methods to a condition of no visible asbestos debris.

(5) The plastic shall be removed and disposed as asbestos waste. Plastic seals to other building areas shall not be broken at this time.

(6) The area shall be recleaned by wet methods.

(7) The area shall be fogged.

(8) Twenty-four hours after fogging, air samples are to be taken in and around the work enclosure; (minimum of 1200 liters of air per sample).. A small fan is used during the sampling to circulate the air and simulate occupant activity.

(9) The fiber/cc count for all samples within the cleaned work areas must be 0.01 or lower. If the samples are not 0.01 or lower the contractor must repeatedly clean and sample until the levels meet this criterion. Once this criterion has been reached, the plastic seals dividing building areas may be removed.

(10) Access areas and contaminated locker area shall be included in the clean-up.

Specific Work to Be Performed: The purchaser and the contractor must agree on the specific work to be performed. If the friable asbestos material is to be removed, encapsulated, or enclosed, the contract should so state. The plastic enclosed areas, locker and shower facilities and access area and hallways should be defined in the contract. If the job is to be completed in discrete sections, the contract should state the order of completion of the projects. If finish work is to take place after the asbestos related work is completed, the contract should include provisions for the scheduling for this also. The contractor is responsible for making sure that all work areas have air sampling levels under 0.01 fibers/cc before further non-asbestos related work proceeds in the area.

IF, AT ANY TIME, THE PURCHASER'S REPRESENTATIVE DECIDES THAT THE WORK PRACTICES ARE VIOLATING PERTINENT REGULATIONS OR ENDANGERING WORKERS, HE WILL IMMEDIATELY NOTIFY IN WRITING THE ON-SITE CONTRACTOR REPRESENTATIVE THAT OPERATIONS ARE IN VIOLATION OF CONTRACT SPECIFICATIONS.

REFERENCES FOR A SAFER AND HEALTHIER WORKPLACE

As technology and the use of chemicals have increased in industry, so has our need for information. There is no single source that will provide you with everything you need. Many of the technical books are expensive except for those produced by the National Institute for Occupational Safety and Health (NIOSH), and state and non-profit organizations; they are often less expensive or free. If you do not wish to purchase expensive references, they can sometimes be found in public or university libraries.

INTRODUCTION TO OCCUPATIONAL SAFETY AND HEALTH ISSUES

1. American Lung Association. Occupational Lung Diseases - An Introduction. NY: ALA, 1979. Individual copies are free. Call (617) 269-9720 or check your local telephone directory for a listing.

   This 80-page booklet presents a non-technical overview to occupational lung diseases. The types of lung hazards are reviewed as well as control methods.

2. Davis, M. and A. Rowland. Occupational Disease Among Black Workers: An Annotated Bibliography. Berkeley, CA: Labor Occupational Health Program, 1980. $5.00. Labor Occupational Health Program, Institute of Industrial Relations University of California, 2521 Channing Way, Berkeley, CA 94702, Tel: (415) 642-5452.

3. International Labour Organization. Encyclopedia of Occupational Health and Safety. Geneva: ILO, 1983. $155.00. ILO, 1750 New York Avenue NW, Washington, D.C. 20006, Tel: (202) 376-2315.

   This two-volume set is an excellent overview of topics in occupational safety and health. Useful references are provided at the end of each topic entry.

4. MassCOSH Women's Committee. Our Jobs, Our Health: A Woman's Guide to Occupational Health and Safety. Boston: MassCOSH and Boston Women's Health Collective, 1983. $7.00. MassCOSH, 718 Huntington Avenue, Boston, MA 02115, Tel: (617) 277-0097 Boston; (413) 732-2847 Springfield.

   This guide includes information on worker rights, how to recognize hazards, and how to work for health and safety improvements in the workplace.

5. Stellman, J.M. and S.M. Daum. Work is Dangerous to Your Health. Random House, New York: Vintage Books, 1973. $5.95. Random House, Tel: 1-800-638-6460.

   This reference is a readable guide to health hazards in the workplace and what you can do about them. It explains how different hazards affect the body and lists the hazards by occupation.

PUBLICATION: #14,476-8-500-3-87-CR
Approved by the State Purchasing Agent

INTRODUCTION TO OCCUPATIONAL SAFETY AND HEALTH ISSUES (cont.)

6. Stellman, J.M. and S.M. Henifin. Office Work Can Be Dangerous To Your Health. New York: Pantheon Books, 1984. $6.95. Random House, Tel: 1-800-638-6460.

   This book provides a comprehensive look at the range of hazards in the office environment. Included are lighting, VDTs, noise, office design and indoor air pollution. Explanations on how to measure these hazards and correct them are also provided.

CHEMICAL HAZARDS

1. American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values for Substances in Workroom Air. Cincinnati: ACGIH, 1985. $110.00. (Updated with annual supplements). American Conference of Governmental Industrial Hygienists (ACGIH), 6500 Glenway Avenue, Cincinnati, OH 45211, Tel: (513) 661-7881.

   This text provides short summaries of the toxic effects of about 500 substances. The summaries document the need for recommended limits {called threshold limit values (TLVs)} on worker exposure for these substances. All of these substances are on the Massachusetts Substance List (MSL).

2. American Conference of Governmental Industrial Hygienists. TLVs - Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Change for 1986-87. Cincinnati: ACGIH, 1986. $4.50. American Conference of Governmental Industrial Hygienists (ACGIH), 6500 Glenway Avenue, Cincinnati, OH 45211, Tel: (513) 661-7881.

   This booklet lists ACGIH's recommended exposure limits.

3. American Industrial Hygiene Association. Hygienic Series. Akron: AIHA, 1980 (updated periodically). Member: $90, Non-member: $125. American Industrial Hygiene Association (AIHA), 475 Wolf Ledges Parkway, Akron, OH 44311, Tel: (216) 762-7294.

   This reference provides a 2-4 page summary on almost 200 common workplace chemicals. The guides also include the toxic effects, Chemical Abstract Service (CAS) numbers and methods of controlling exposures.

4. American Industrial Hygiene Association. Industrial Hygiene: A Guide to Technical Information Sources. Akron, OH: AIHA, 1984. Member: $9.00, Non-member: $19.00. American Industrial Hygiene Association (AIHA), 475 Wolf Ledges Parkway, Akron, OH 44311, Tel: (216) 762-7294.

   This book provides a systematic guide to sources of technical information in industrial hygiene. Listings of currently available reference works and texts, government documents and journals are found in this book.

CHEMICAL HAZARDS (cont.)

5. Barlow, S.M. and F.M. Sullivan. Reproductive Hazards of Industrial Chemicals. New York: Academic Press, 1982. $82.50. Academic Press Inc., Orlando, FL 32887, Tel. (305) 345-4100.

   In this text, almost 50 industrial compounds are reviewed for their effects on fertility (male and female) and teratogenic effects. Both animal and human data are summarized.

6. Burgess, W. Recognition of Health Hazards in Industry. N.Y.: John Wiley and Sons, 1981. $38.00. John Wiley and Sons, 600 3rd Avenue, New York, NY 10022, Tel: (212) 850-6000.

   This book reviews the operations and health hazards of a variety of industrial settings with an emphasis on controlling these hazards through engineering design.

7. Clayton, G.D. and F. Clayton. Patty's Industrial Hygiene and Toxicology, Vol. II. Toxicology. New York: John Wiley and Sons, 1982. Volume II is divided into 3 parts: Part A: $147.00, Part B: $104.00, Part C: $133.00. John Wiley and Sons, 600 3rd Avenue, New York, NY 10022, Tel: (212) 850-6000.

   This is a classic reference for topics in occupational safety and health.

8. Environmental Protection Agency (EPA). Chemical Emergency Preparedness Program: Chemical Profiles. Washington D.C.: EPA, 1985. Free. Contact EPA: 1-800-535-0202.

   This is a set of over 400 profiles of chemicals that are on the EPA's list of acutely toxic chemicals. The profiles are in a format similar to material safety data sheets and provide a summary documenting the hazards.

9. Finkel, A.J. Hamilton and Hardy's Industrial Toxicology. Boston: John Wright-PSG, Inc., 1983. $49.00. John Wright-PSG, Inc., 545 Great Road, Littleton, MA 01460, Tel: (617) 486-8971.

   This text is designed for medical professionals and students but is accessible to non-medical people. It covers the toxic effects of metals, chemical compounds, pesticides, radiant energy, etc.

10. Hawley, G.G.. The Condensed Chemical Dictionary. New York: Van Nostrand Reinhold Company, Inc., 1981. $46.75. Van Nostrand Reinhold Company, Inc., 7625 Empire Drive, Florence, KY 41042-0668, Tel: (606) 525-6600.

    This reference provides technical, but clear explanations of chemical terms and processes. It also identifies the chemical identity, uses and properties of many trade name products. Entries are cross-referenced.

11. Levy, B. and D. Wegman. Occupational Health: Recognizing and Preventing Work-Related Disease. Boston: Little, Brown and Company, 1983. $29.00. Little, Brown and Company, 200 West Street, Waltham, MA 02254, Tel: (617) 227-0730.

    This source provides an overview of the diseases and disorders caused by workplace exposures. Useful, annotated bibliographies follow each chapter.

CHEMICAL HAZARDS (cont.)

12. Massachusetts Division of Occupational Hygiene. Recommended Safe Practices Bulletins. Boston: Mass. DOH. Free. Massachusetts Division of Occupational Hygiene, 1001 Watertown Street, West Newton, MA 02165, Tel: (617) 969-7177.

    The collection consists of information on workplace hazards and methods for controlling these hazards in a variety of work settings. Includes recommendations for safe practices and exposure limits.

13. National Institute for Occupational Safety and Health (NIOSH). Registry of Toxic Effects of Chemical Substances. Washington, D.C.: U.S. Government Printing Office, 1983-84. NIOSH Publication No. 83-107, Three volumes. Out of print. See Public or University libraries. Superintendent of Documents, U.S. Governmental Printing Office, Washington, D.C. 20402, Tel: (202) 783-3238.

    This is an exhaustive reference (with data on 39,000 chemicals), but somewhat difficult to use. The entries are brief and use abbreviations.

14. NIOSH, Pocket Guide to Chemical Hazards. Washington, D.C.: U.S. Government Printing Office, 1985. NIOSH Publication No. 85-114, GPO Stock No. 017-033-00418-8. Individual copies are free. NIOSH Publications, 4676 Columbia Parkway, Cincinnati, OH 45226.

    A convenient, pocket-sized book that has summary tables on almost 400 chemicals including their properties, exposure limits, health effects and protective equipment.

15. National Safety Council. Fundamentals of Industrial Hygiene. Chicago: National Safety Council, 1979. $53.00. National Safety Council, 444 North Michigan Avenue, Chicago, Illinois 60611, Tel: (312) 527-4800.

    This reference is a useful textbook for recognizing, evaluating and controlling workplace hazards. It includes information on numerous chemicals.

16. National Toxicology Program (NTP). Fourth Annual Report on Carcinogens: Summary. Research Triangle Park, N.C.: NTP Publication 85-002. Free. NTP Public Information Office, Box 12233, Research Triangle Park, NC 27709, Tel: (919) 541-3991.

    This booklet describes chemical substances and manufacturing processes known or suspected to cause cancer in humans.

17. N.J. Department of Health. Hazardous Substance Fact Sheets. $.25 each, first ten are free. N.J. Department of Health, CN 368, Trenton, NJ 08625, Tel: (609) 984-2202.

    The collection is made up of almost 500 easy-to-read information sheets on substances on the N.J. Workplace Hazardous Substance List. The information is very thorough, useful for trainings.

CHEMICAL HAZARDS (cont.)

18. N.Y. State Department of Health. Chemical Fact Sheets. $100/package or $.50/each sheet, NY State Resident: no charge. For out of state order: Health Education Services Ink, Inc., P.O. Box 7126, Albany, NY 12224.

    These 200 chemical fact sheets are similar to MSDSs (Material Safety Data Sheets) but are written in lay-language.

19. O'Connor and Lirtzman. Handbook of Chemical Labeling. Park Ridge, NJ: Noyes Publications, 1984. $64.00. Noyes Publications, 120 Mill Road, Park Ridge, NJ 07656, Tel: (201) 391-8484.

    This book is designed to provide an indepth review of, and act as a source for, the major elements of a Hazard Label Communication Program.

20. Office of the Federal Register. Code of Federal Regulations: Labor: 29: Parts 1900 to 1910. Washington, D.C.: GPO, 1985. Free. Contact OSHA: Regional Office, Boston, (617) 223-6710; Waltham, (617) 647-8681; Springfield (413) 785-0123.

    This governmental document contains regulations issued by the Occupational Safety and Health Administration (OSHA). It includes occupational safety and health standards.

21. Proctor, N.H. and J.P. Hughes. Chemical Hazards of the Workplace. Philadelphia: J.P. Lippincott, 1978. $39.50. Harper and Row, 2350 Virginia Avenue, Hagerstown, MD 21740, Tel: 1-800-638-3030.

    This basic reference book gives information on the uses, toxic effects, medical tests and treatments for about 400 industrial substances. It was written primarily for physicians.

22. Sax, N.I. Dangerous Properties of Industrial Materials. 6th Edition. New York: Van Nostrand Reinhold Co., 1984. $225. Van Nostrand Reinhold Company, Inc., 7625 Empire Drive, Florence, KY 41042-0668, Tel: (606) 525-6600.

    This edition contains the synonyms and toxicological data for 18,000 substances, with a greater emphasis on safety hazards (i.e., flammability, explosivity and reactivity). The entries are brief and use technical abbreviations.

EMERGENCY SITUATIONS: FIRE & SPILLS

1. American Lung Association of Western New York, Inc. Chemical Emergency Action Manual. St. Louis: The C.V. Mosby Co., 1983. Out of print. See public or university libraries. The C.V. Mosby Company, 11830 Westline Industrial Drive, St. Louis, Missouri 63141, Tel: (314) 872-8370.

   Easy-to-read fact sheets on about 60 substances. Medical instructions are provided along with information on how to control spills, leaks, fires and exposures.

2. National Fire Protection Agency (NFPA). Fire Protection Guide on Hazardous Materials, 9th Edition. Quincy, MA: NFPA, 1986. Member: $39.60, Non-member: $44.00. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269, Tel: 1-800-344-3555.

   This reference provides information on fire hazard properties of flammable liquids, gases, and volatile solids; fire, explosion and toxicity for hazardous chemicals; hazardous chemical reactions; and a recommended system for the identification of the fire hazards of materials.

3. Student, P.J. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, D.C.: Bureau of Explosives, Association of American Railroads, 1981. Bureau of Explosives, Association of American Railroads, 1920 L Street, N.W., Washington, D.C. 20036, Tel: (202) 639-2132.

   This reference gives action response information on all hazardous materials regulated by the U.S. Department of Transportation. It is very useful for spill clean-up and firefighting.

4. Stutz, D. et al. Hazardous Materials Injuries: A Handbook for Pre-Hospital Care. Greenbelt, MD: Bradford Communications, 1982. $16.95. Bradford Communications, 7329 Baylor Avenue, College Park, MD 20740, Tel: (301) 345-0100.

   This book presents in-the-field protocols on different substances for paramedical personnel and Emergency Medical Technicians prior to transporting victims to a medical facility.

5. U.S. Department of Transportation. Emergency Response Guidebook. Washington, D.C.: DOT, Materials Transportation Bureau, 1984. Publication No. DOT P 5800.3. Single copy available upon request. Free. U.S. Department of Transportation, Office of Hazardous Material Transportation, Research Special Program Administration, 400 7th Street, S.W., Washington, D.C. 20590, Tel: (202) 366-2301.

   It is an emergency action guide that provides data on firefighting and evacuation procedures for a range of chemicals.

PERSONAL PROTECTIVE EQUIPMENT

1. ACGIH, Guidelines for The Selection of Chemical Protective Clothing. Cincinnati: ACGIH, 1983. $35.00. ACGIH, American Conference of Governmental Industrial Hygienists, Inc., 6500 Glenway Avenue, Building D-5, Cincinnati, OH 45211, Tel: (513) 661-7881.

   This document contains comprehensive tables of recommendations to aid in the selection of chemical protective clothing.

2. Birkner, L.R. Respiratory Protection: A Manual and Guideline. Akron, OH: American Industrial Hygiene Association, 1980. Member: $12.00, Non-member: $22.00. AIHA, American Industrial Hygiene Association, 475 Wolf Ledges Parkway, Akron, OH 44311, Tel: (216) 762-7294.

   The purpose of this book is to assist employers in protecting employees and complying with the OSHA respiratory protection standard.

3. NIOSH, Certified Equipment List: Respirators, Coal Mine Dust, Personal Sampler Units. Washington, D.C.: U.S. Government Printing Office, 1985. GPO Stock No. 017-033-00422-6. $13.00. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, Tel: (202) 783-3238.

   This publication lists respirators and coal mine dust personal sample units certified by NIOSH as of October 1, 1985. It also lists the limitations for specific groups of respirators.

4. NIOSH, Respiratory Protection - A Cuide for the Employee. Cincinnati: NIOSH, 1979. PB80189301, NIOSH Publication No. 78-193B. $9.95. National Technical Information Service (NTIS), Port Royal Road, Springfield, VA 22161, Tel: (703) 487-4650.

   This booklet discusses the basics of respiratory protection. Topics include selecting the appropriate respirator, medical aspects of respirator usage, maintenance and fit-testing of respirators.

5. NIOSH, Respiratory Protection: An Employer's Manual. Cincinnati: 1978. PB80184401, NIOSH Pub. No. 78-193A. $11.95. National Technical Information Service (NTIS), Port Royal Road, Springfield, VA 22161, Tel: (703) 487-4650.

   This manual is designed to aid the small employer in complying with the OSHA requirements for a respiratory protection program.

6. Rajhams, G.S. and D.S.L. Blackwell. Practical Guide to Respiratory Usage in Industry. Stoneham, MA: Butterworth Publishers, 1985. $24.95. Butterworth Publishers, 80 Montvale Avenue, Stoneham, MA 02180, Tel: (617)438-8464.

   This book details a total respiratory protection program and each of its individual components.

TRAINING AND EDUCATIONAL MATERIALS

1. Finn, P. Teaching Occupational Safety and Health at the Secondary and College Level. Reston, VA: Association for the Advancement of Health Education, 1979. Out of print. See public or university libraries. Association for the Advancement of Health Education, 1900 Association Drive, Reston, VA 22091, Tel: (703) 476-3400.

   This book is an instructor's guide on how to include job safety and health topics in school curricula. It includes a variety of learning activities.

2. Labor Occupational Health Program. Labor Educator's Health and Safety Manual. Berkeley, CA: LOHP, 1983. $15.00. Labor Occupational Health Program, Institute of Industrial Relations, University of California, 2521 Channing Way, Berkeley, Ca 94702, Tel: (415) 642-5452.

   The Manual presents an intensive training program aimed at unionists. It is designed to provide them with the skills and knowledge needed to serve as in-house experts on health and safety.

3. Massachusetts Coalition for Occupational Safety and Health (MassCOSH). Fact sheets on many chemicals, occupations, etc. $.50 each fact sheet. MassCOSH, 718 Huntington Avenue, Boston, MA 02115, Tel: (617) 277-0097 Boston; (413) 732-2847 Springfield.

4. NIOSH. Audio Visual Resources in Occupational Safety and Health: An Evaluative Guide. Cincinnati: NIOSH, 1981. PB83105395, NIOSH publication #82-102. $11.95. National Technical Information Service (NTIS), Port Royal Road, Springfield, VA 22161, Tel: (703) 487-4650.

   This guide is a compilation of critical reviews of audiovisual training materials on the broad subjects of occupational safety and health.

5. OSHA, A Resource Guide to Worker Educational Materials. Washington, D.C.: U.S. DOL-OSHA, 1982, Free. U.S. Department of Labor, OSHA Office of Publication Distribution, Room S-1212, Third & Constitution Avenue, N.W., Washington, D.C. 20210, Tel: (202) 523-6666 or 376-6228.

   This guide lists occupational safety and health materials - written, audio-visual, textual or outline format - suitable for worker training and education.

6. OSHA, OSHA Publications and Audiovisual Programs. Washington, D.C: OSHA, 1986. OSHA 2019 (Revised). U.S. Department of Labor, OSHA Office of Publication Distribution, Room S-1212, Third & Constitution Avenue, N.W., Washington, D.C. 20210. Free single copies can be obtained by calling OSHA: Boston (617) 223-6710; Springfield (413) 785-0123.

MASSACHUSETTS DIVISION OF OCCUPATIONAL HYGIENE
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No. 1400 A March, 1987

MUNICIPAL RIGHT TO KNOW FACT SHEET

This fact sheet will highlight the worker portion of the Massachusetts Right to Know Law. It will not cover the community right to know process. For further information on the municipal coordinator's role and aspects of the community's right to know, contact the Department of Environmental Quality Engineering (DEQE), Right to Know Office at (617) 292-5810.

Following are details helpful in implementing the Massachusetts Right to Know Law as it applies to cities and towns:

WORKPLACE:

Many employees (for example, firefighters, inspectors, etc.) enter private and public workplaces in the community to perform their job duties. In these cases the definition of the workplace is expanded and includes all those private and public worksites. For training purposes, generic training is permitted to inform employees about the potential hazards to which they may be exposed. The request for MSDSs (for products in other worksites) is the same for municipal employees as other employees. They must give a written request to their municipal employer. The municipal employer (or the Right to Know Coordinator for the city or town) must make a written request for the MSDS to the employer, where the product is used or stored, to get the MSDS for the municipal employee.

ESSENTIAL PERSONNEL:

Employees covered by the RTK Law have the right to obtain and examine MSDSs for any substance to which the employee is, may be, or has been exposed. An employee may refuse to work with that substance if the employer has not furnished the requested MSDS or proof of diligent effort within four working days from the date of the written request (see p. 25 for more information). Public employees classified as performing essential service may not refuse to work with a substance under any circumstances. Municipalities may classify certain job titles or positions as "essential". Employees are to be notified of this decision in writing by the municipality. A copy of the written determination that the job is essential must be kept in a central location with the MSDSs, and employees must have access to the written determination. Employees have the right to appeal this designation to the Commissioner of Labor and Industries.

Note: The designation of employees as "essential" only applies to the right to refuse to work. All other aspects of the RTK Law (MSDSs, labeling, and training) still apply.

REIMBURSEMENT:

The costs of implementing the worker portion of your Right to Know Program may be reimbursable by the State. Most municipalities are familiar with the fiscal restraints imposed by Proposition 2 1/2. However, Proposition 2 1/2 places the responsibility on the State to reimburse cities and towns for the cost of implementing any new State mandated program. The RTK Law is the first law of this kind.

Reimbursement guidelines and associated forms have been sent to all cities and towns. You should review this material to become familiar with the reimbursement process and to know which expenditures are actually reimbursable. If you have any questions or need further information contact the Reimbursement Coordinator in the Office of Administration and Finance at (617) 727-2081.

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
James F. Snow, COMMISSIONER

DIVISION OF OCCUPATIONAL HYGIENE
Richard Levine, DIRECTOR
1001 Watertown Street, West Newton 02165
Telephone (617) 969-7177

No. 1401 March, 1987

MSDS CRITERIA SHEET

Following are criteria that must be satisfied in order for a Material Safety Data Sheet (MSDS) to comply with the Massachusetts Right to Know Law.

Whether or not the manufacturer and preparer of the MSDS is located in Massachusetts, all MSDSs supplied to Massachusetts users covered by the Right to Know Law must comply with these criteria. The Department of Labor and Industries advises employers to insert a clause in their purchasing contracts that allows refusal of shipments of any first order not accompanied by a properly completed MSDS.

Employers should use the following criteria to review MSDSs so that they may, in turn, justify returning any incomplete MSDS to the manufacturer. For the benefit of the manufacturer, this sheet, properly checked, should accompany all returned MSDSs, so the manufacturer will know what information is missing and can promptly return it completed. Be sure to keep a copy for your own files.

Please note that all spaces must be filled out, even if only to say "Not Applicable".

PRODUCT NAME _____

PREPARER

_____ Name of manufacturer or supplier
_____ Complete street address
_____ Emergency telephone number
_____ Date MSDS was compiled or revised

*HAZARDOUS INGREDIENTS/CHEMICAL IDENTITY

_____ Chemical name of product if a pure substance, or of each ingredient in a mixture **
_____ Common name(s), if they exist
_____ C.A.S. (Chemical Abstract Service) number of product if a pure substance or of each hazardous ingredient in a mixture (C.A.S. numbers are listed on Massachusetts Substance List.)
_____ Percentages of each hazardous ingredient

PHYSICAL DATA

_____ Boiling point
_____ Vapor density
_____ Vapor pressure
_____ Flash point
_____ Other pertinent physical data

SAFETY DATA

_____ Fire hazards
_____ Explosion hazards
_____ Reactivity

HEALTH RISK DATA

_____ Acute and chronic health effects in non-technical terms
_____ Any carcinogenic, teratogenic, mutagenic or neurotoxic effects as designated on the Massachusetts Substance List
_____ Medical conditions that may be aggravated by exposure
_____ Routes of exposure, i.e., inhalation, skin, eyes and ingestion
_____ Symptoms of overexposure

SPECIAL PRECAUTIONS

_____ Proper safety precautions
_____ Safe handling procedures
_____ Proper protective equipment

EMERGENCY PROCEDURES

_____ First aid
_____ Emergency medical treatment
_____ Emergency fire procedures
_____ Spill procedures
_____ Disposal procedures

CONTROL MEASURES

_____ Recommended engineering controls (specify)
_____ Recommended personal protective equipment (specify)

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* If a product is approved as a trade secret by the Massachusetts Department of Public (DPH) Health, the manufacturer may omit the chemical name, common name, CAS number or percent from the MSDS. DPH assigns an eight-digit number to all approved trade secret products. All number begin with 99-. An example would be 99-999-999.

** Only those substances and ingredients listed on the Massachusetts Substance List must be provided. Please note, however, that if the product is not hazardous, the notation "No hazardous ingredients regulated by the Massachusetts Right to Know Law" must be written in the Hazardous Ingredients section of the MSDS. Only ingredients in concentrations of 1% or more must be listed. Exceptions are impurities in a mixture (must be at least 2%) and Extraordinarily Hazardous Substances (at least 1 part per million/ppm).

MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES
James F. Snow, COMMISSIONER

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